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VOLUME XX

JUNE, 1931 TO MARCH, 1932
(Complete in ten numbers)

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ERRATA IN VOLUME 18

Page 91, line 14 from top "teken" should read "taken".

Page 99, line 6 from top "*Pristopoma hasta*" should read "*Mesopristes plumbea* (Kner).

Page 101, line 13 from top "of algae and a duckweed, locally known as *lia* (*Lemna paucicostata* Hegelm.)" should read "of algae known locally as *lia* and a duckweed (*Lemna paucicostata* Hegelm.)"

Page 102, line 18 from top "*Pristopoma hasta*" should read "*Mesopristes plumbea*" (Kner) and "*Miragobius*" should read "*Mirogobius*".

ERRATA IN VOLUME 19

Page 4, line 2 from bottom "20 days" should read "28 days."

Page 5, line 4 from bottom "ranging from 1 to 18 months duration" should read "ranging from 12 to 18 months duration".

Page 307, line 15 from top "*Melania scrabra* Müller (Melaniidae)" should read "*Melania scabra* Müller (Melaniidae)."

Page 317, line 23 from top "*Datnia plumbea* Kner" should read "*Mesopristes plumbea* (Kner)".

ERRATA IN VOLUME 20

Page 11, line 17 from top "*Aeciduim paederia* Dietel" should read "*Aecidium paederiae* Dietel."

Page 25, line 8 from bottom "101.02 kgm." should read "4.85 kgm."

Page 26, line 12 from bottom "101.02 kgm." should read "4.85 kgm."

Pages 68, 69, 70 from headings of tables 2 and 3 "(Sampling done simultaneously)" should read "(Samples were taken one right after the other)".

Page 111, line 6 from bottom "boekoek" should read "boeboek".

Page 114, line 8 from top "(*Ipomoea batatas* Linn.) (Poir)" should read "*Ipomoea batatas* (Linn.) Poir."

Page 114, line 18 from top "*Amorphophalus campanulatus* (Roxb.) Blume ex Deene.)" should read "*Amorphophalus campanulatus* (Roxb.) Blume".

Page 402, line 13 from bottom "four substances" should read "five substances".

Pages 405 and 406, the following list gives the correct common and scientific names of animal foods (fish and by-products) found in the table:

Fish:

- Fresh:
  - Anchovy, *Anchovia commersoniana* (Lacépede); dilis (Tag.)
  - Gizzard shad, *Anodontostoma chacunda* (Hamilton-Buchanan); kabasi(Tag.)
  - Caesio, *Caesio* spp. (Pomadasidae); dalagang-bukid (Tag.)
  - Catfish, *Arius* spp. (Ariidae); kanduli (Tag.), gague (Moro)
  - Catfish, *Clarias batrachus* (Bloch), hito (Tag.)
  - Croaker, *Johnius belengeri* (Cuvier et Valenciennes), abo (Vis. and Bicol)
  - Drepane, *Drepane punctata* (Gmelin), mayang (Tag.)
  - Sea bass, *Lates calcarifer* (Bloch), apahap (Tag.)

Flathead, *Patycephalus indicus* (Linn.), sunog (Tag.)
Flounder, *Pseudorhombus neglectus* (Bleeker); palad (Tag.)
Goby, *Glossogobius giurus* (Hamilton-Buchanan); biyang-puti (Tag.)
Grunt, *Mesopristes plumbea* (Kner); ayuñgin (Tag.)
Surmullet, *Upenoides sulphureus* (Cuvier et Valenciennes), bisogo (Tag.)
Half-beak, *Hemiramphus quoyi* (Cuvier et Valenciennes), boguin (Tag.)
Herring, *Harengula* spp. (Clupeidae); tunsoy, (Tag.)
Japanese mackerel, *Scomber japonicus* Houttuyn; hasa hasa (Tag.)
Leather Jack, *Scomberoides tol* (Cuvier et Valenciennes); talupak, cassisung (?) (Tag.)
Marine eel, *Muraenesox cinerus* (Forskål); palos (Tag.)
Milk fish, *Chanos chanos* (Forskål); bañgos (Tag.)
Mudfish, *Ophicephalus striatus* Bloch; dalag (Tag.)
Mullet, *Liza troscheli* (Bleeker); banak (Tag.)
Mullet, *Mugil cephalus* Linn.; talilong (Tag.)
Grunt, *Pristopoma hasta* (Bloch); bakoko (Tag.)
Sardine, *Sardinella* spp. (Clupeidae); tamban (Tag.)
Scatophagus argus (Boddaert); kitang (Tag.)
Therapon, *Therapon* spp. (Theraponidae); bagoong (Tag.)

By products:
Dilis (Engraulidae), (dried salted fish)
Tinapa (Clupeidae), (smoked fish)
Tuyo (Clupeidae), (dried salted fish)

Shellfish:
Fresh:
Alimango, *Scylla serrata* (Forskål) (Portunidae)
Alimasag, *Portunus pelagicus* (Linn.)

Pages 407 and 408 the following corrections are made in scientific names of plants foods:

Fruits:
Amargoso (ampalaya), *Momordica charantia* Linn.
Opo (úpo), *Lagenaria leucantha* (Duch.) Rusby
Kamansi, *Artocarpus communis* Forst.
Cowpea (sitau), *Vigna sinensis* (Linn.) Savi
Patola, *Luffa cylindrica* (Linn.) M. Roem.
Sprouted mungo, *Phaseolus aureus* Roxb.
Sweet pea (guisantes), *Pisum sativum* Linn.
Tomato, *Lycopersicum esculentum* Mill.
Kondol, *Benincasa cerifera* Savi
Winged beans, kalamismis, *Psophocarpus tetragonolobus* DC.

Leaves:
Kangkong, *Ipomoea reptans* (Linn.) Poir.
Celery, *Apium graveolens* Linn.
Mostaza, *Brassica integrifolia* (West) O. E. Schulz
Garlic, *Allium sativum* Linn.
Pechay, *Brassica pekinensis* (Lour.) Gagnep
Kulitis, *Amaranthus viridis* Linn.
Sweet potato, *Ipomoea batatas* (Linn.) Poir.
Onion, *Allium cepa* Linn.
Taro, *Colocasia esculentum* (Linn.) Schott

Fruits:

Avocado, *Persea americana* Mill., *Persea gratissima* Gaertn.
Bignay, *Antidesma bunius* (Linn.) Spreng.
Chico, *Achras zapota* Linn.
Duhat, *Eugenia cumini* (Linn.) Druce.
Jak fruit, *Artocarpus integra* (Thunb.) Merr.
Lansones, *Lansium domesticum* Correa.
Mabolo, *Diospyrus discolor* Willd.
Makopa, *Eugenia javanica* Lam.
Pineapple, *Ananas comosus* (Linn.) Merr.
Pummelo, *Citrus maxima* (Burm.) Merr.
Santol, *Sandoricum koetjape* (Burm. f.) Merr.

Page 489, line 8 from top "the teeth of the concaves" should read "the teeth of the cylinders and the teeth of the concaves."

Page 512, line 14 from bottom "Baracuda" should read "Barracuda".

Page 645, line 9 from top "belonging to the genus *Potamon* or *Parathelpusa*, family Potamonidae or its near relative," should read "belonging to the species *Ptycognathus onyx* Alcock."

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SEPARATE

OVER-PRODUCTION[1]

The world is face to face with a new problem—one of general over-supply of the staple agricultural and manufactured products as a result of increased activity in farming and industrial enterprises. In principle the problem is not altogether new, as in the past there has been a local over-supply of certain products in various regions at different times. Another aspect of the same situation of a world over-supply of a certain product, such as has occurred periodically with wheat, cotton, coffee, etc., has also been noted in the past. But at no time before has there been a general over-supply of not only most agricultural products, but also those of industry. This situation can largely be attributed to the period of peace reigning after the long period of decreased supplies resulting from a large share of the population of the world being unproductive owing to their being engaged in warfare, and another significant portion engaged in the manufacture of materials of destruction. Under such conditions of relative want the productive group had to strain itself to produce enough to feed and clothe the rest engaged in ungainful occupations. Under this strain of necessity the farmers of the world attained a level of efficiency of production sufficient to meet demands, curtailed as they were. With peace prevailing over most of the world, the population has shifted its activities from destruction to gainful occupations. This has transformed a large bulk of the world population from exclusive consumers to marginal producers. With new standards of production it did not take long to change the world situation from a deficiency to a surplus. The post-war change has been gradual; armies had to be mustered out gradually, devastated homes and those deteriorated through years of neglect had to be reconstructed, general destruction had to be repaired, but most important of all, the shattered nerves of the war torn population required time for adjustment. Hence the release of productive forces has been gradual. In past eras of somewhat similar conditions, the needs for a growing population have grown in proportion with increased efficiency in production, but in the present period the industry of the population has gone ahead of its needs, hence the over-supply. As an over-supply of any product offers no stimulus for further production, it follows that if the situation were left to economic laws it would gradually adjust a close balance between production and consumption.

The present world, however, does not sit supinely, patiently waiting for a general readjustment. In their own little spheres the governments of the world have sought to protect their nationals by means of tariff walls to prevent their local products from feeling the full effect of world competition. The degree of protection sought by local products has increased steadily and hence there has been of late an orgy of tariff legislation in all parts of the world. The effect of all this when viewed from the standpoint of the larger interests of the world and mankind has not been altogether fortunate. It seeks to perpetuate high producing areas at the expense of low producing ones—a very uneconomic consequence. It has been observed time and time again that attempts to beat economic laws are mere palliatives, and that the after effects very often defeat their primary purpose. Most of the time they cause only ripples in a big wave. In the long run economic laws will dictate that regions peculiarly adapted to certain crops are to be devoted to the cultivation of such crops. The gradual change to this is bound to continue, and while it would be quite sanguine to expect a complete readjustment on this basis, progress will be continuous and fairly regular.

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[1] General contribution from the College of Agriculture No. 290.

As means of transportation improve, as commerce between different countries increases, it will aid materially in a better readjustment of producing areas.

Because products as meats, fruits, and vegetables are perishable and as a rule cost more to transport, local produce will always enjoy a certain advantage over imported products. It is therefore incumbent upon every nation, nay every community, to so place their farming operations as to be self-supporting in this type of goods, as well as of their staple food. For the greater area of the farms, and for the larger enterprises, the suitability of the land and locality should be determined and the crops best adapted to it, the ones that can be profitably produced should be grown. This plan may have as a consequence the fallowing of large areas unsuitable to economical production under existing conditions.

Under present conditions of over-production only good land should be farmed, as every unit of product produced at a loss is that much of a setback on the individual producer, hence it were better it should be not produced.

As world conditions change continuously, land unprofitable today may become profitable tomorrow and hence become available for farming once more. The process reduces itself to a keen insight and a flexible attitude of mind in one's farming operations.

B. M. Gonzalez,
Dean, College of Agriculture.

Achievement that is worthy of admiration springs from perseverance.
—Chinese Maxim.

AECIOID SHORT CYCLE RUSTS OF THE PHILIPPINE ISLANDS[1]

F. L. STEVENS AND VICTORIA B. MENDIOLA
Of the Department of Plant Pathology

WITH NINE TEXT FIGURES

More than 16 rust forms supposed to be aecial have been listed as occurring in the Philippines. They have all been regarded as of the form genus *Aecidium* and erected as form species.

Of these 16 forms we have been able to secure viable material of 10 and have made germination tests which have shown that five of these are really telial not aecial stages, therefore do not belong to the form genus *Aecidium* as previously supposed, but to the telial genus *Endophyllum* of the family Melampsoraceae. Four germinate as true aecia and indeed are known to be long cycle rusts by their other spore forms. One, though alive, did not give any germination.

For germination we find it very satisfactory to plant the spores on the surface of plain agar, 1000 cc. of distilled water to 25 grams of agar. This was poured, sterile, into a petri dish using 10 cc. which gave on cooling a layer of agar about 1 mm. thick. Slabs of this about 1 cm. square were cut out and laid on slides. After planting the spores, the slides were placed in a moist chamber, the most convenient form consisting of a 14 cm. petri dish in which the slides were supported on a stage above water. This agar served perfectly and there appears to be no need of resorting to Beijerinck's agar (Kunkel, 1916). Spores often germinated well on bare glass but did not proceed to develop well. Sowings on the surface of water gave germinations but not so uniformly. Bits of tissue bearing sori were teased apart and placed so that they were not covered with water but merely wet (Olive and Whetzel, 1917). These gave germinations, but were unsatisfactory for examination, owing to the presence of too much extraneous matter. The most satisfactory spores are those naturally dropped from the sori. To secure these, suitable host parts were suspended over the agar for a few hours or over-night. The spores thus secured were mature and were nicely distributed over the agar surface, not in dense clumps as is the case when teased bits or scrapings are used. Immature spores and other useless material are also avoided, and there is less contamination from other fungi. Sometimes good results are attained by pressing the sori gently upon the agar. Fungi of several sorts that grow upon rust spores abound in the Philippines and cause much trouble. These are less troublesome if the spores are merely allowed to fall upon the agar without bringing the sori or host into contact with the agar.

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[1] Experiment station contribution No. 716. Received for publication March 11, 1931.

Germination usually was evident in a few hours, but observation of septation and promycelia was best made at 24 or 36 hours.

Slight differences in promyceliar behavior and in sporidia are observed in the different species as is noted below. In general when the promycelium grows into humid air it is short, septate, and bears from one to four sterigmata all of which may bear sporidia.

In many instances the sterigmata are not determinate but grow on apparently indefinitely as a mycelial thread, a germ tube (Arthur and Fromme, 1915) about one-fifth the diameter of the promycelium, and probably are capable of infecting the host. Mature sporidia drop off and germinate by a tube precisely like that just mentioned. Quite frequently the sporidia germinate *in situ*, even before they attain full size, (fig. 2, b).

Bizarre shapes of promycelia, curved, branched, etc., are not rare, (fig. 8).

When the promycelium grows in liquid, it grows to approximately twice the length attained in air, but is still determinate in growth and clearly evinces here its promycelial nature, thus differing from the Porto Rican rusts as described by Olive and Whetzel (1917) who say, "If, on the other hand, the spores are completely immersed, the tubes then appear much like those from true aeciospores."

Olive and Whetzel (1917) recognize three genera of *Endophyllum*-like rusts which may be separated by the following key:

Spores catenulate:
Peridium absent .... *Endophylloides*
Peridium present .... *Endophyllum*
Spores not catenulate:
Peridium none .... *Botryorhiza*

All of our species possess a peridium and catenulate spores and therefore are to be regarded as of the genus *Endophyllum*. There are, however, large differences between species as to the development of the peridium, In the rust on *Paederia* it is very strongly developed, in *E. kaernbachii* it is scant.

The condition exhibited by so many of these Philippine rusts taken in connection with the same condition shown by the Porto Rican rusts and by "*Caeoma nitens*" in warm regions seems to indicate that the elision of the other two spore forms is comparatively easy of accomplishment, perhaps consisting merely in hastening the conjugation of the gamete nuclei. If this be so perhaps we can rid our minds of undue reverence for stage III for taxonomic purposes and regard "*Kunkelia*" as expressing merely a physiological adaptation to climate and not consider it as a separate genus or even species but merely as a physiological form of *Gymnoconia interstitialis* (Atkinson [1918], and Clinton [1920]).

Indeed, it is conceivable that more of these rusts have the ability to change the time of nuclear fusion and with this of promycelial germination. *E. superficiale*, (see p. 11), shows a parallel condition to that of *Gymnoconia interstitialis* in that they are sometimes short cycle and other times long cycle. Perhaps after all, *Aecidium kaernbachii*, now *Endophyllum superficiale* really pertains to *Puccinia convolvuli* as Sydow first thought (1914a and b). It is also possible that all *Endophyllums* represent conditions of *Puccinia* or similar genera where the promycelial development occurs in the aecioid stage rather than elsewhere.

In all of these rusts pycnia were unusually scant, many spots showed none under the hand lens and when they were present there were usually very few. In no instance were they seen to develop an open ostiole, filaments or spores. This apparent recession of the pycnia in these short cycle rusts may be of significance taken in connection with recent findings which show some pycnia to be functional (1927).

ENDOPHYLLUM BLUMEAE (HENNINGS) STEVENS AND MENDIOLA COMB. NOV.

Aecidium blumeae Hennings, Hedwigia **47**: 252. 1908.

O. Pycnia punctiform, honey yellow, few to many, none observed to open.

III. Telia—strictly hypophyllous in clusters, sparse or gregarious; pale, cup-shaped. Peridium fimbriate, well elevated above the surface, peridial cells hyaline, irregular, 14-21µ, minutely rough; teliospores, subglobose to angular, minutely rough, sub-hyaline, slightly orange-colored, 14µ in diameter or 14×17µ.

Spot not hypertrophied, round or effuse, pale or yellow above when young, reddish yellow below, mostly 1-3 mm. in diameter, sometimes 5 mm. or more. Old spots brown and dead, sub-circular, 4-7 mm. in diameter (fig. 1).

On *Blumea balsamifera* and *B. laciniata*

The present studies were made on specimen No. 475 on *Blumea balsamifera* collected at the College of Agriculture, Los Baños, Laguna, Philippine Islands, September 5, 1930, by F. L. Stevens.

Previously recorded Philippine collections are:

On *B. balsamifera.*
  Lepanto, Luzon, Merrill, 4938.
  Taytay, Luzon, Merrill, 8740.
  Malasugat, Mindanao, Merrill, Sydow; Fungi Exotici 23.
On *B. laciniata*, Manila, Merrill, 7466.

Other collections by us on *B. balsamifera* are:

No. 85, Los Baños Rock Crusher, Laguna, July 24, 1930.
No. 96, College of Agriculture, Los Baños, Laguna, July 25, 1930.
No. 449, College of Agriculture, Los Baños, Laguna, September 3, 1930.
No. 475, College of Agriculture, Los Baños, Laguna, September 5, 1930.
No. 580, Sariaya, Tayabas, September 14, 1930.

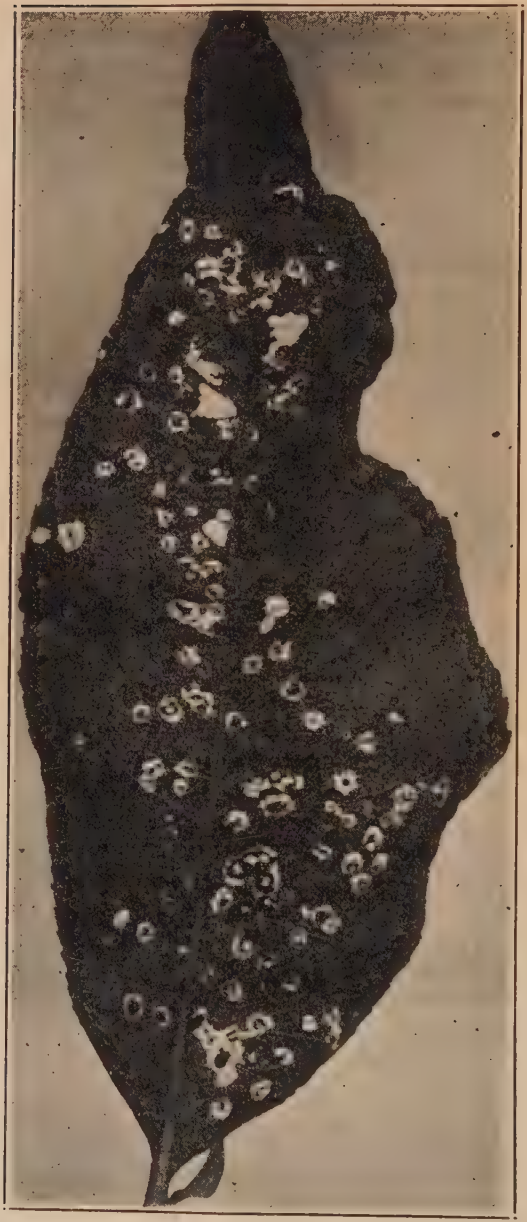

Fig. 1.—*Endophyllum blumeae* general aspect of diseased leaf from above. Slightly smaller than the original.

Collections in the Charles Fuller Baker Herbarium of the Department of Plant Pathology are:

On *Blumea balsamifera*
 No. 21838, Angat, Bulacan.
 No. 17261, Mount Maquiling, Los Baños, Laguna.
 No. 23, Malasugat, Zamboanga.
 No. 8740, Taytay, Palawan.
 No. 1, Mount Maquiling, Los Baños, Laguna.

On *Blumea* sp.
 No. 6774, Cabancalan, Negros

On *B. laciniata.*
 No. 7466, Manila and vicinity.

References
 1908 Hennings, Hedwigia **47**: 252.
 1912 Saccardo et Trotter, Sylloge Fungorum **21**: 767.
 1912 Sydow, Annales Mycologici **10**: 352.
 1913 Sydow, Philippine Jour. Sci. C, **8**: 267.
 1914 Sydow, Philippine Jour. Sci. C, **9**: 159—Taytay, Palawan.
 Exsicattus: Sydow, Fungi Exotici No. 23—Malasugat, Mindanao.

The fungus is very widespread and abundant. Germinated on agar in moist chamber, the spores produced short promycelia 50-150 μ long which were 2 or 3 septate, more often 2 septate, (fig. 2, a). The sporidia are ovate to pyriform, 7×11 μ. Often the sporidia initial cells germinate directly into germ tubes, (fig. 2, b). Spores sown in hanging water drop formed promycelia that were longer than those borne on agar, but they were not indeterminate in growth though they produced no sterigmata or sporidia. Frequently the sporidia germinate *in situ* (fig. 2, b).

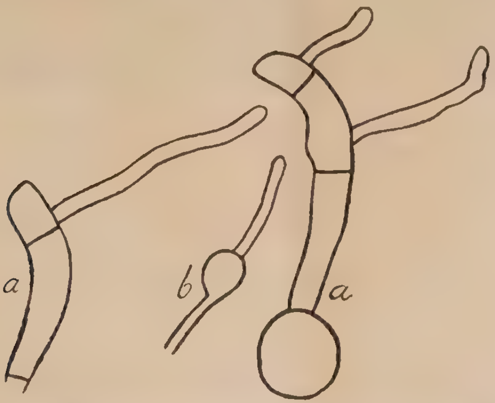

Fig. 2.—*Endophyllum blumeae* (*a*) germination of teliospores and formation of germ tubes from the sporidia initial cells. (*b*) a sporidium germinating *in situ.*

ENDOPHYLLUM KAERNBACHII (HENNINGS) STEVENS AND MENDIOLA COMB. NOV.

Aecidium kaernbachii Hennings, Engler Botanische Jahrbücher **15**: 5. 1892.

O. Pycnia usually none, sometimes many, punctiform, honey yellow, epiphyllous, not seen to open.

III. Telia strictly hypophyllous, usually few in the centers of the spots, sometimes circularly arranged, at first covered then erumpent, reddish, cup-shaped, nearly globose in section, 225-255 μ across, 225 μ deep.

Peridium very slightly elevated, about 30 μ above the leaf surface. Peridial cells similar to spores but more angular and less colored.

Teliospores catenulate, hyaline or slightly orange tinted, slightly roughened, oval or slightly angular, 17×11 μ (Hennings' description reads 10-23 μ)

Spot pale yellow above and below, 2-3 mm. to a centimeter in diameter, leaf swollen from 150 to 375 μ in the region of the telia. Old spots dead at center and tan colored. On *Ipomoea hederacea*, *Merremia umbellata* (fig. 3), *Merremia vitifolia*, *Lepistemon obscurum* = (*Lepistemon flavescens*) *Hewittia sublobata.*

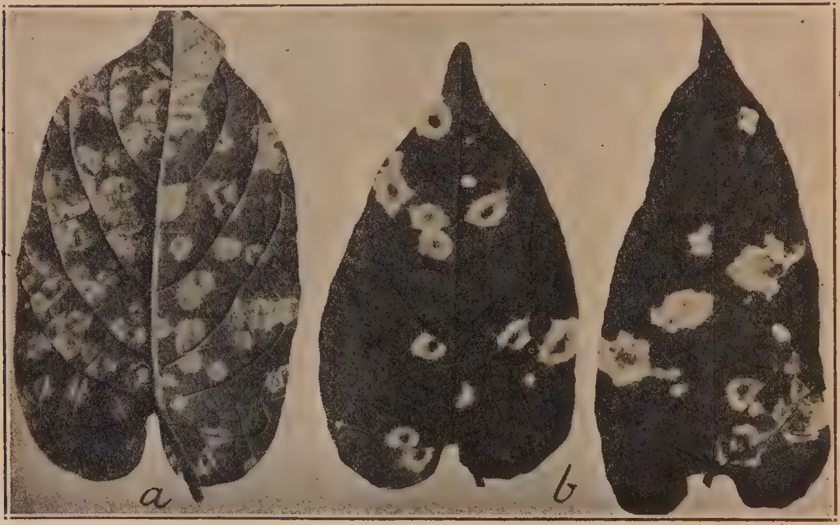

Fig. 3.—Leaves of *Merremia umbellata* showing sori of *Endophyllum kaernbachii*, (*a*) lower surface view and (*b*) upper surface view

The present studies were made on specimen No. 480 on *Merremia umbellata* collected at the College of Agriculture, September 8, 1930, by F. L. Stevens.

Previously recorded Philippine collections are:

On *Ipomoea hederacea* (Butler).

On *Ipomoea* sp.
  Manila and Samar, Copeland, 46; Merrill, 4893, 5227.

On *Merremia umbellata.*
  Zamboanga, Mindanao; Tubig, Samar; Rizal, Luzon; Dumarao, Panay.

On *Merremia vitifolia.*
  Graff, Mount Mariveles, Bataan; Cabancalan, Negros.

On *Lepistemon flavescens.*
  Zamboanga, Mindanao; between San Pablo and Nagcarlang, Laguna.
  Merrill, 7485; San Antonio, Los Baños, Laguna.

On *Convolvulaceae.*
  Mount Urdaneta, Mindanao, Elmer, 13332.

Other collections by us are:

On *Hewittia sublobata.*
No. 6, Calauan, Laguna, July 12, 1930.
No. 92, Los Baños, Laguna, July 24, 1930.
No. 98, College of Agriculture, Los Baños, Laguna, July 25, 1930.
No. 444, College of Agriculture, Los Baños, Laguna, September 1, 1930.

On *Lepistemon obscurum.*
No. 73, Mount Maquiling, Los Baños, Laguna, July 22, 1930.
No. 90, Los Baños, Laguna, July 22, 1930.
No. 226, College of Agriculture, Los Baños, Laguna, August 13, 1930.
No. 447, College of Agriculture, Los Baños, Laguna, September 3, 1930.
No. 486, College of Agriculture, Los Baños, Laguna, September 10, 1930.
No. 644, Mount Maquiling, Los Baños, Laguna, September 20, 1930.
No. 694, Pagsanjan, Laguna, September 21, 1930.

On *Ipomoea* sp.
No. 319, College of Agriculture, Los Baños, Laguna, August 19, 1930.

On *Merremia umbellata.*
No. 52, College of Agriculture, Los Baños, Laguna, July 17, 1930.
No. 69, Mount Maquiling, Los Baños, Laguna, July 22, 1930.
No. 87, Los Baños, Laguna, July 24, 1930.
No. 358, Lake Taal, Batangas, August 23, 1930.
No. 410, Mount Maquiling, Los Baños, Laguna, August 30, 1930.
No. 480, College of Agriculture, Los Baños, Laguna, September 8, 1930.
No. 661, Botocan Falls, Laguna, September 21, 1930.

Collections in the Charles Fuller Baker Herbarium are:

On *Lepistemon flavescens.*
No. 26, Bagasan River, Zamboanga, Mindanao; Sydow, Fungi Exotici 26.
No. 7485, San Pablo to Nagcarlan, Laguna.
No. 9261, Pauai, Benguet Subprovince, Luzon.
No. 11201, Cavite Province.
No. 23768, San Antonio, Los Baños, Laguna.
No. 25328, Kalinga Subprovince, Luzon.

On *Merremia umbellata.*
No. 5227, Tubig, Samar.
No. 6711, Dumarao, Panay.
No. 7065, Rizal, Luzon.

On *M. umbellata* (=*Ipomoea cymosa*).
No. 25, Bagasan River, Zamboanga, Mindanao, Sydow, Fungi Exotici 25.

On *Merremia vitifolia.*
No. 6768, Cabancalan, Negros.
No. 17261, Mount Maquiling, Los Baños, Laguna.
On ?
No. 13332, Cabadbaran, Agusan, Mindanao.

On *Ipomoea.*
No. 1679, Zamboanga, Mindanao.

References

1892 Hennings, Engler Botanische Jahrbücher **15**: 5.
1906 Sydow et Butler, Annales Mycologici **4**: 441.
1908 Hennings, Hedwigia **47**: 252.

1912 Sydow, Annales Mycologici **10**: 352.
1912 Petch, Annals Royal Botanical Garden Peradeniya **5**: 245.
1913 Sydow, Leaflets Philippine Botany **6**: 1913.
1913 Sydow, Philippine Jour. Sci. C, **8**: 267.
1912 Sydow et Butler, Annales Mycologici **10**: 273.
1914 Sydow, Annales Mycologici **12**: 111.
1914 Baker, Leaflets Philippine Botany **6**: 2068.
Exsicatus: Sydow, Fungi Exotici Nos. 25 and 26.

The sporidia are from 1 to 3 per basidium, borne on tapering sterigmata, (fig. 4, a). The promycelium is usually 50-75×7 µ. Frequently the sporidia initial cells develop directly to infection threads, (fig. 4, b), and germination of the sporidia *in situ* is not rare, (fig. 4, c). The irregular behavior of the promycelium, sterigmata and sporidia is more common than in any other species studied.

In hanging drop of water was profuse germination, but no sterigmata, though the growth was determinate.

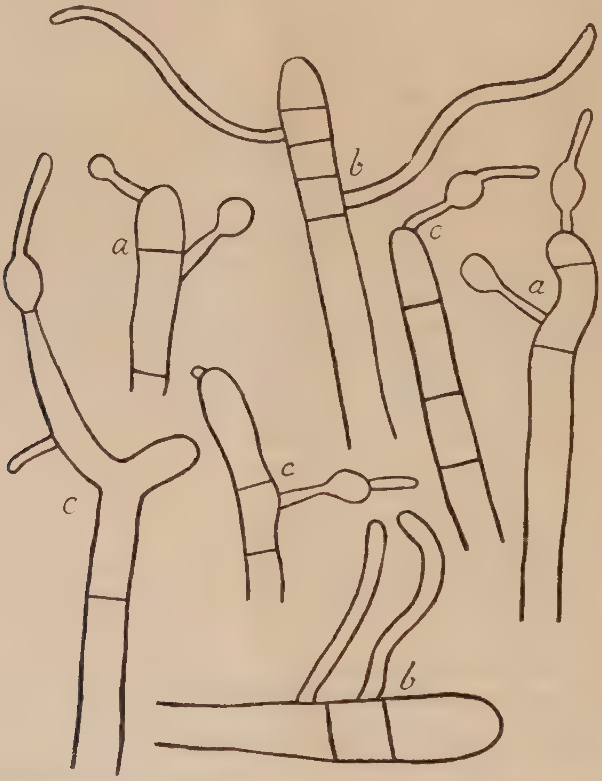

Fig. 4.—*Endophyllum kaernbachii*, (*a*) promycelia; (*b*) direct germination of sporidia initial cells; (*c*) germination of sporidia *in situ*.

All of the observations recorded above are based upon lowland specimens, therefore from tropical climate.

Since this article was submitted for publication we have had opportunity to germinate an aecioid form on *Lepistemon obscurum* collected on Mount Santo Thomas near Baguio in a temperate climate. This fungus agrees morphologically with *Aecidium superficiale*, more commonly known as *Aecidium kaernbachii*, collected in the Luzon lowlands on the same host, but the spores germinate with long indeterminate infection tubes, not by promycelia.

It appears therefore that we have in the Philippines two forms of this rust; one a short cycle form in the warm lowlands, the other a long cycle form in the temperate highlands, though the telial stage of the highland form has not yet been seen.

The case quite parallels that of *Gymnoconia* on *Rubus* in the United States which shows a short cycle form in the southern United States and a long cycle form in the northern United States, though in that case the aecioid form is a *Caeoma*, not an *Aecidium* as it is in this case.

ENDOPHYLLUM PAEDERIAE (DIETEL) STEVENS AND MENDIOLA COMB. NOV.

Aecidium paederia Dietel, Hedwigia **36**: 297. 1897.

O. Pycnia often absent, sometimes few, or very numerous, epiphyllous, dark, not seen to open.

III. Telia mainly hypophyllous, occasionally epiphyllous, especially on the veins, frequently few, even solitary on a spot, or when on large spots very numerous, yellow or reddish, cupulate, about 180 μ across and 300 μ deep.

The peridium, 1-cell thick, is much elevated above the leaf surface, 50-120 μ, and is fimbriate. The peridial cells are angular and rough, like the spores, but hyaline.

Teliospores catenulate, ovoid, irregular or subglobose, 16-21×12-17 μ slightly rough, at the apex usually strongly thickened, 4-5 μ.

Spot on leaves circular or irregular or following the veins and elongate, often very minute, 0.5 mm., sometimes large, 4-10 mm. in diameter. From above, slightly sunken, brown in center, red bordered. From below, yellow or red, strongly hypertrophied, forming warts, usually from 1 to 3 mm. across and the leaf being thickened from 225 μ to more than 750 μ. On stems or large veins much hypertrophy occurs and galls a centimeter or more long are produced (fig. 5).

On *Paederia tomentosa* (=*P. foetida*)

The present studies were made on specimen No. 516 collected at the College of Agriculture, Los Baños, Laguna, September 11, 1930, by F. L. Stevens.

The original description was made from material of Miyoshi from Tokyo, Japan.

Previously recorded Philippine collection is:

On *Paederia foetida*, Manila, Merrill, 8566 and Stevens' 137.

Other collections by us are:

On *Paederia foetida*

No. 615, College of Agriculture, Los Baños, Laguna, September 19, 1930.
No. 689, Pagsanjan, Laguna, September 21, 1930.
No. 946, College of Agriculture, Los Baños, Laguna, November 15, 1930.
No. 1002, Paete, Laguna, September 16, 1930.

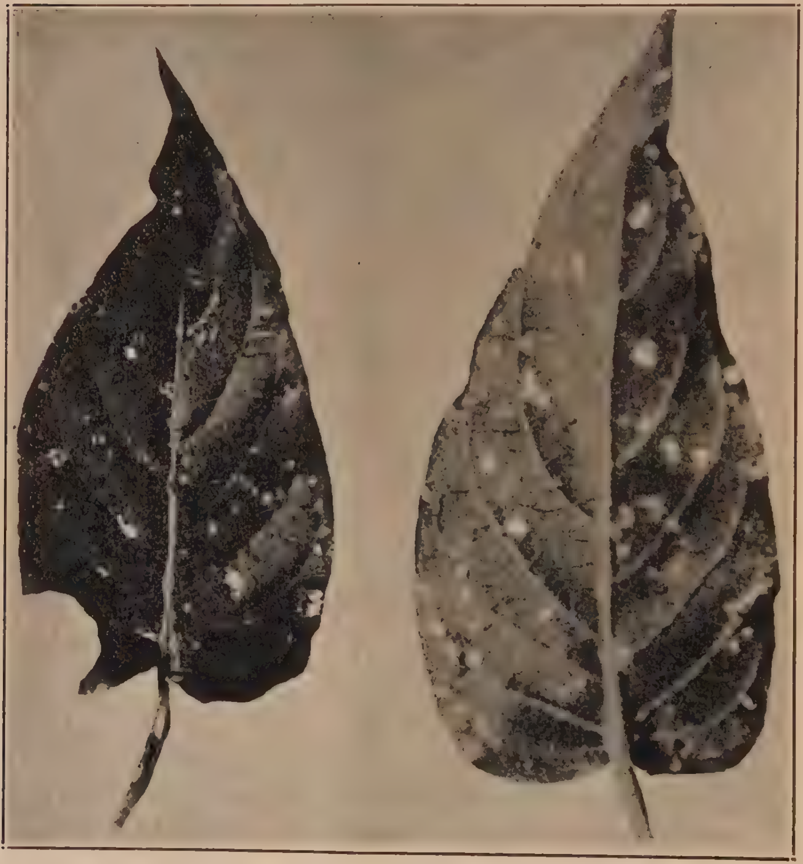

Fig. 5.—*Endophyllum paederiae* showing leaves from above and below.

Collections in the Charles Fuller Baker Herbarium are:

On *Paederia foetida*

No. 302, Los Baños, Laguna.
No. 8566, Manila and vicinity.
No. 21914, Rizal, Luzon.

References

1913 Sydow, Philippine Jour. Sci. C, **8**: 477.
1912 Sydow et Butler, Annales Mycologici **10**: 273.
1914 Sydow, Annales Mycologici **12**: 111—Formosa.

The spores germinate well on bare glass and 4-spored promycelia have been seen so to develop though the tubes are not quite normal. On agar there are quite often 4 sporidia, occasionally 1-2, or 3, (fig. 6, a).

The promycelia may be straight or crooked and are usually about 60×7 μ though often they are much shorter.

The sporidia initial cells sometimes grow directly to an infecting hypha, (fig. 6, b).

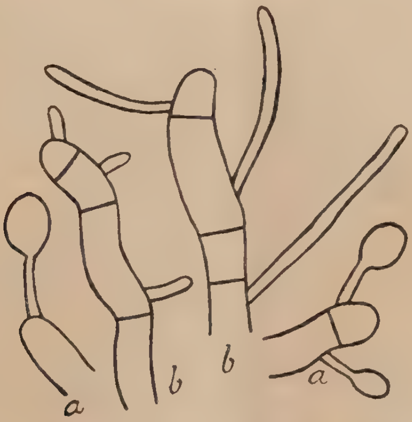

Fig. 6.—*Endophyllum paederiae*, (*a*) promycelia; (*b*) direct germination of sporidia initia cells.

ENDOPHYLLUM SUPERFICIALE (KARST. AND ROUM.) STEVENS AND MENDIOLA COMB. NOV.

Aecidium superficiale Karst. and Roum. Revue Mycologique[2] **12:** 78, 1890.
Aecidium clerodendri Hennings, Engler Botanische Jahrbücher **15:** 6, 1892.

O. Pycnia epiphyllous, punctiform, honey yellow, sparse, often arranged in circles. No evidence was had of their opening.

III. Telia red, almost strictly hypophyllous, exceedingly rare above. Peridium cupulate, well raised above the surface, 75 μ. Peridial cells by compression angular, size same as that of spores.

Teliospores catenulate, polygonal to sphaeroid or oval, smooth, slightly orange tinted, granular, 16-25 μ in diameter.

Spot pale and irregular, yellow above when young, slightly or much raised, arched. Below, yellow or reddish with numerous clustered aecioid sori. Spots from 1 or 2 mm. to 2 cm. in diameter, when large much hypertrophied. With age spots turn black on both surfaces and the tissue dies. Later, the dead spots fall out by abscission.

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[2] Sydow, *in* Annales Mycologici **26:** 427. 1928, asserts that *Aecidium clerodendri* P. Henn. and *Aecidium superficiale* are identical.

On *Clerodendron intermedium, C. calamatosum, C. fragrans,* and *C. quadriloculare.*

The present studies were made on specimen No. 448, on *C. intermedium* (fig. 7) collected at the College of Agriculture, Los Baños, Laguna, September 3, 1930 by F. L. Stevens, and on specimen No. 1010 on *C. quadriloculare,* collected at Santa Cruz, Laguna, November 16, 1930.

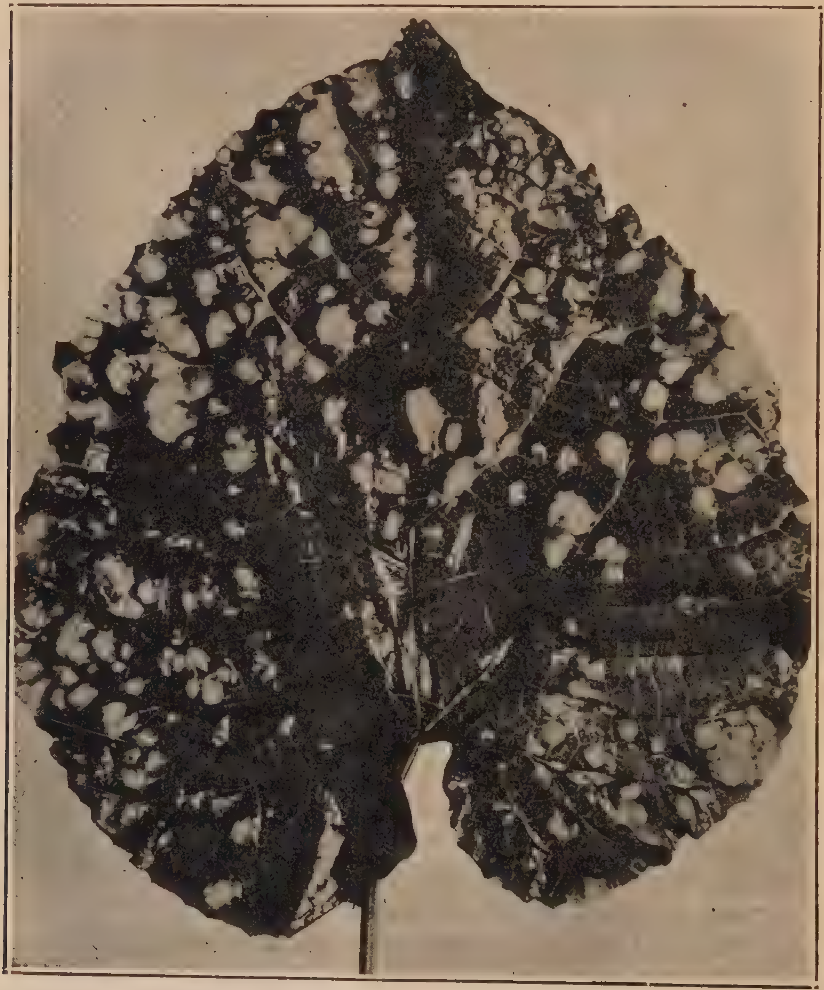

Fig. 7.—A leaf of *Clerodendron intermedium* showing the general infection and the hypertrophy.

Previously recorded Philippine collections are:

On *Clerodendron calamatosum,* Luzon, Merrill, 4198:
San Isidro, Nueva Ecija, Merrill, 4198 (?).

On *Clerodendron intermedium*, Manila, Merrill, 6322:
Los Baños, Baker, 740; near Manila, Graff, also Merrill, 8570.
On *Clerodendron fragrans*, between San Pablo and Nagcarlan, Laguna, Merrill, 7484.

Other collections by us are:

On *C. intermedium*
No. 59, College of Agriculture, Los Baños, Laguna, July 18, 1930.
No. 89, Los Baños Rock Crusher, Laguna, July 24, 1930.
No. 225, College of Agriculture, Los Baños, Laguna, August 13, 1930.
No. 357, Lake Taal, Batangas, August 23, 1930.
No. 448, College of Agriculture, Los Baños, Laguna, September 3, 1930.
No. 481, College of Agriculture, Los Baños, Laguna, September 9, 1930.
No. 558, Sariaya, Tayabas, September 14, 1930.
No. 617, College of Agriculture, Los Baños, Laguna, September 19, 1930.
No. 669, Nagcarlang, Laguna, September 22, 1930.
No. 724, Cuenca, Batangas, September 28, 1930.
No. 1219a, School of Forestry, Los Baños, Laguna, November 17, 1930.
No. 985, Paete, Laguna, November 16, 1930.
On *C. quadriloculare*
No. 879, Santa Cruz, Laguna, November 10, 1930.

Collections in the Charles Fuller Baker Herbarium are:

On *Clerodendron intermedium*
No. 740, Los Baños, Laguna.
No. 201, Mount Maquiling, Los Baños, Laguna.
No. 1971, Los Baños, Laguna.
No. 6322, Manila.
No. 8570, Manila and vicinity.
No. 740, Los Baños, Laguna.

References
1892 Hennings, Engler Botanische Jahrbücher **15**: 6.
1908 Hennings, Hedwigia, **47**: 252—Luzon.
1908 Hennings, Philippine Jour. Sci. C, **3**: 43, San Isidro, Nueva Ecija.
1910 Sydow, Philippine Jour. Sci. C, **5**: 164—Manila.
1913 Sydow, Philippine Jour. Sci. C, **8**: 267.
1914 Sydow, Annales Mycologici **12**: 111.

The sporidia are usually 1 or 2, sometimes 3 per basidium.

In water the promycelium was never of indeterminate growth, but always ceased growth when about 180 μ long, thus clearly showing its promycelial nature though such promycelia did not produce sporidia. When the promycelium is aërial, sporidia are produced and the promycelium is shorter, about 50 μ. The sporidia are produced on short sterigmata, about 11-14 μ long usually, though somewhat variable, tapering from base to distal end, (fig. 8, a). The sporidia are oval and about 11×7μ. Occasionally the sterigmata branch, (fig. 8, b). The sporidia germinate by a long slender infection tube, (fig. 8, c).

No difference was observable in the germination of spores taken from different hosts.

ENDOPHYLLUM CASSIAE (BRES.) STEVENS AND MENDIOLA COMB. NOV.

Aecidium cassiae Bres. Revue Mycologique **13:** 66, 1891.

Ae. torae Hennings, Engler Bot. Jahrb. **34:** 42, 1904.

O. Pycnia not seen.

III. Telia almost strictly hypophyllous, rarely a few epiphyllous, roughly circularly arranged, 150-225 μ in diameter, cup-shaped, shallow, 150 μ. Peridium extending somewhat above the leaf surface, 75-150 μ.

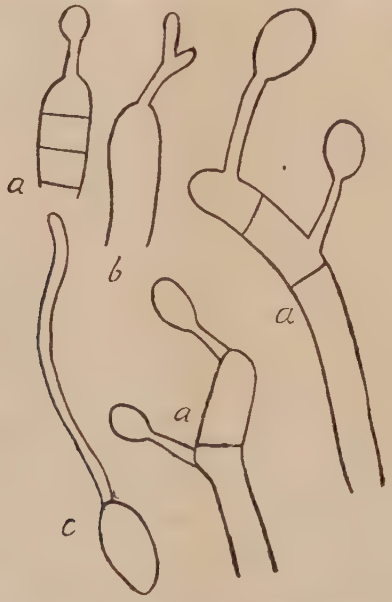

Fig. 8.—*Endophyllum superficiale*, (*a*) promycelia, sterigmata, and sporidia; (*b*) a forked sterigma; (*c*) a germinating sporidium.

Peridial cells irregularly angular, hyaline, rough, 28×21 μ.

Spores catenulate, yellow, thin-walled, minutely punctuate, globose to oblong, 18 μ in diameter or 18×21 μ.

Spot from above slightly sunken, yellow when young, black and dead when old, showing almost no hypertrophy. Spots from below yellow and bearing numerous telia, up to 8 mm. in diameter.

On *Cassia tora*

College of Agriculture, Los Baños, Laguna, December 8, 1930, F. L. Stevens, No. 1100.

This species is distinguished from the American form, *Ae. chamaecristae* Arth. by its almost strictly hypophyllous sori, its smaller peridial cells and smaller spores.

The promycelia are rather short, usually about 40-50 μ though sometimes more than 100 μ long, and 10 μ thick at the distal end and are most frequently two septate.

The promycelial cells most frequently produce an infection germ tube (fig. 9) rather than sporiferous sterigmata, while in some instances this infection tube though quite long may function as a sterigma bearing a sporidium at its tip.

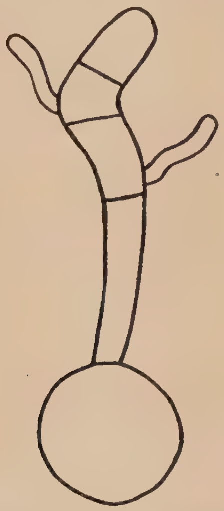

Fig. 9.—Germination of *Endophyllum cassiae.*

Previously recorded Philippine collection is on *Cassia tora*, Butuan, Mindanao, Merrill, 7346. Collection in the Baker Herbarium is as above.

References

1904 Hennings, Engler Botanische Jahrbücher **34**: 42.
Saccardo, Sylloge Fungorum **11**: 214.
Saccardo, Sylloge Fungorum **17**: 427.
Exsiccatus: Sydow, Fungi Exotici 72, Basagan River, Zamboanga; Sydow, Monographia Uredinearum, 2300.

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Arthur, J. C., and F. D. Fromme. 1915. A new North American Endophyllum. Bull. Torrey Bot. Club **42**: 55–62. *Pl. 1–2.*

Atkinson, G. F. 1918. Selected cycles in *Gymnoconia peckiana*. Amer. Jour. Bot. **5**: 79–83.

Baker, C. F. 1914a. The lower fungi of the Philippine Islands. Leaflets of Philippine Botany **6**: 2065–2190.

Baker, C. F. 1914b. First supplement to the list of the lower fungi of the Philippine Islands. Leaflets of Philippine Botany **7**: 2417-2542.

Clinton, G. P. 1920. Diseases of raspberry. Connecticut (New Haven) Agric. Exper. Sta. Bull. 222: 469–473.

Craigie, J. H. 1927. Experiments on sex in rust fungi. Nature **120**: 116–117.

Kunkel, L. O. 1916. Further studies on the orange rusts of *Rubus* in the United States. Bull. Torrey Bot. Club **43**: 559–569. *Fig. 1–5.*

Olive, E. W., and H. H. Whetzel. 1917. Endophyllum-like rusts of Porto Rico. Amer. Jour. Bot. **4**: 44–52. *Pl. 1–3.*

THE FERTILIZING CONSTITUENTS OF FRESH SOLID EXCRETA VOIDED BY PHILIPPINE HORSES[1]

VALENTE VILLEGAS, MAMERTA MANAHAN, AND F. T. ADRIANO
Of the Departments of Animal Husbandry and Agricultural Chemistry

There is considerable waste of soil fertilizers in the Philippines through the manner of handling the horse manure from the stables. Horse owners should exercise more care and show a greater interest in the collection and storage of the excreta of their horses. By so doing they would save for their crops large amounts of fertilizer now being wasted.

The work reported in this paper, was performed to obtain information on the capacity of Philippine horses to produce fresh solid excreta and to find out the approximate fertilizing value of such material. The specific objects of this investigation were as follows: (1) To determine the amount of fresh solid excreta voided by Philippine horses; (2) to find out the relationship between the daily amount of fresh feces voided and the live weight of the animal; (3) to obtain by chemical analysis the percentage amount of moisture, ash, nitrogen, phosphoric acid, potash and lime contained in the feces; and (4) to ascertain the relative amounts of phosphoric acid, potash, and lime contained in the ash obtained from the feces.

This investigation was begun on October 7, 1927 and closed January 24, 1929, covering a period of about 15½ months. It was undertaken at the College of Agriculture, University of the Philippines.

THE HORSES

Nine Philippine horses were used in this work, five of which were males and four females. At the beginning of the experiment the youngest horse was 2 years and 3 months old and the oldest, was 18 years, 6 months. The average weight of the animals throughout the period of investigation ranged from 203.8 to 253.6 kgm.; the average weight of all was 235.3 kgm. (see table 1).

FEEDING AND MANAGEMENT

The feeding and management of the horses were supervised as closely as possible in conformity with the requirements of the experiment, without, however, sacrificing the practical aspect of the work. The animals were kept in separate stalls from six o'clock in the morning to seven o'clock in the evening; at night they were placed in their respective boxstalls. They were given all that they would readily consume of green roughage, consisting mostly of Guinea grass and corn forage and Napier grass in lesser quantities.

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[1] Experiment Station contribution No. 717. Read before Los Baños Biological Club January 15, 1931. Received for publication January 17, 1931.

Villegas (1929), found that Philippine horses eat as much as an average of 14.1 kgm. of soilage per head daily. A common grain mixture of three parts, by weight, of shelled corn, three parts of rice bran, and one part of copra meal, was supplied to the horses used in this study at the rate of about two kgm. of the concentrate per head daily. The roughage was fed in the stall in the daytime. With grain, the first feeding was made in the morning in the stall, and what remained was placed in the boxstall in the evening. The horses were watered three times daily and salt was provided *ad libitum* in salt boxes built in each boxstall. The horses were curried and other routine care necessary to keep them in good health was given. Exercise was provided by having each horse do some form of light work.

TABLE 1

Showing the sex, age, and average weight of Philippine horses used

HORSES	SEX	AGE AT BEGINNING OF EXPERIMENT	AVERAGE WEIGHT THROUGHOUT EXPERIMENT
			kgm.
Herd No. 2...	Male	15 years	237.0
Herd No. 4...	Female	18½ years	230.4
Herd No. 10...	Male	4 years	216.4
Herd No. 15...	Female	2 yrs. 10 mos.	265.8
Herd No. 17...	Male	2 yrs. 3 mos.	203.8
Herd No. 18...	Male	5 years	231.4
Herd No. 19...	Female	3½ years	227.8
Herd No. 20...	Female	6 years	251.9
Herd No. 26...	Male	8 years	253.6

COLLECTION OF FECES

An empty kerosene can was labeled and set aside for a container in which the feces of each horse was placed. The day's collection included all dung voided from 6:00 a. m. one day to 6:00 a. m. the next day, that is a period of 24 hours. In gathering the feces dropped during the night, care was exercised that the litter and other substances adulterating it were removed before it was put into the container. The solid excreta voided in the field or road, when a horse was taken out for work or other purposes, was scooped up and included in the day's collection. The day's voidings were weighed at six o'clock the following morning. Any error in the weight of feces caused by the urine with which the dung might have become mixed was minimized by collecting the solid excrement as soon as it was dropped on the floor of the stall, and by placing sufficient bedding in the boxstalls to absorb any urine which accumulated on the dirt floor.

TABLE 2

Showing the frequency of voiding of feces made by Philippine horses daily

DATE	HERD NO. 2	HERD NO. 4	HERD NO. 10	HERD NO. 15	HERD NO. 17	HERD NO. 18	HERD NO. 19	HERD NO. 20	HERD NO. 26
1927									
October 20		11	12			11			
October 29		13	11	8		10	9		5
November 5		6		8	9	13	8		
November 12		5	9	4	6	13	9		
November 19				6	5		8		
November 26		9	7	9	7				
December 3					9		12		
December 13		10	8	12	8	8	14		7
December 25			8	8	8	10	10	8	9
1928									
January 17			6	6	6	7	10	4	5
February 7			6	8	8	10	9	5	7
February 28			6	7	7	9		4	6
March 30			4		7	11		5	9
April 10	7		5		9	10		4	7
May 8			4		6	6		5	5
July 18			4			8			5
August 22			7			10			8
September 19	6		7			9			7
October 17	7		7			9			7
November 22	8		7			9			9
December 13	7		7			7			13
Average	7.0	9.0	6.9	7.6	7.3	9.4	9.9	4.6	7.3

During the collection of feces, several counts were made of the frequency of voiding by each horse. Clearly enough, in the daytime there was no difficulty in recording the voidings, provided that the dung was gathered as soon as it was dropped. In the night, however, not infrequently the solid excreta was thrown in heaps making it impossible to determine the number of voidings an animal had made. The counts reported in this paper refer only to cases in which the frequency of voiding was accurately determined.

SAMPLING AND PROCEDURE FOLLOWED IN CHEMICAL ANALYSIS

The feces submitted for chemical analysis were collected from random voidings by each horse, each sample being analyzed separately. The date of collection was more or less uniformly distributed throughout the period of investigation. Collection was made as soon as the feces were dropped thus insuring freshness and avoiding chemical changes which might take place if they had been stored, even if a preservative had been used to prevent deterioration.

TABLE 3

Showing the amount of feces voided by Philippine horses

THIRTY-DAY PERIOD	HERD NOS. 2, 4 AND 20			HERD NO. 10			HERD NO. 18			HERD NO. 26		
	Amount voided	Range in amount voided daily	Average amount voided daily	Amount voided	Range in amount voided daily	Average amount voided daily	Amount voided	Range in amount voided daily	Average amount voided daily	Amount avoided	Range in amount voided daily	Average amount voided daily
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm*
		Herd No. 4										
First	284.1	5.9–13.9	9.5	166.5	2.3– 8.4	5.6	194.9	4.2–10.1	6.5	205.1	4.1– 9.7	6.8
Second	284.0	5.6–14.1	9.4	227.5	5.2–10.2	7.6	253.3	5.0–13.4	8.4	219.7	3.8-10.6	7.3
		Herd No. 20										
Third	138.2	2.3– 7.9	4.6	192.3	2.4–10.0	6.4	166.5	2.5—9.7	5.6	138.8	2.5 7.7	4.6
Fourth	141.0	2.9– 6.8	4.7	184.7	3.7– 9.5	6.1	164.4	3.2– 7.8	5.5	169.7	3.6– 8.4	5.7
Fifth	137.4	3.2– 6.4	4.6	165.0	4.1– 7.7	5.5	163.5	3.2– 8.4	5.5	184.0	4.1– 9.2	6.1
Sixth	151.1	3.2– 9.3	5.0	147.0	3.2– 7.0	4.9	183.9	4.3– 8.3	6.1	190.8	4.5– 8.6	6.4
Seventh	175.7	3.8– 7.7	5.8	151.7	3.6– 6.1	5.0	197.5	4.5– 9.2	6.6	218.9	4.7– 9.5	7.3
Eighth	199.6	4.1–10.0	6.6	166.5	4.1– 7.3	5.6	171.4	4.1– 7.7	5.7	210.5	5.0– 8.6	7.0
		Herd No. 2										
Ninth	218.1	2.3–13.2	7.2	179.2	2.7– 8.2	6.0	172.8	3.6– 9.5	5.8	201.5	4.5–10.4	6.7
Tenth	226.6	4.4–12.2	7.5	219.5	2.7–10.4	7.3	168.4	2.5–10.4	5.6	203.2	3.2–10.0	6.8
Eleventh	200.7	3.6–11.3	6.7	200.5	4.3– 9.3	6.4	267.8	5.9–11.8	8.9	218.2	4.3–10.2	7.3
Twelfth	232.5	4.1–11.8	7.7	190.5	3.2–12.2	5.4	226.3	3.6–12.0	7.5	175.9	3.8–10.4	5.9
Total	2389.0			2190.9			2330.7			2336.3		
Range		2.3–14.1			2.3–12.2			2.5–13.4			2.5–10.6	
Average	199.1		6.6	182.6		6.0	194.2		6.5	194.7		6.5

Soon after the feces were received at the analytical laboratory, different portions were taken for the determination of moisture, nitrogen and ash contents. A large part of the material was burned for ash which was set aside for the determination of phosphoric acid, potash, and lime.

The methods of chemical analysis used were in accordance with the directions embodied in the *Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists* (1925).

DISCUSSION OF RESULTS

Frequency of voiding

The averages in the frequency of voiding of feces made by nine horses ranged from 4.6 to 9.9. The general average for all was 7.7. It was observed that defecation did not take place until late in the morning. In the afternoon, voiding was frequent and regular. The feces were passed out a number of times at night also.

Amount of feces voided

As will be seen in table 3, six animals were used in determining the amount of feces voided by Philippine horses. The voidings of Nos. 2, 4, and 20 were added to constitute a year's production for all of them. The rest of the animals gave each a year's output of solid excreta. From the daily records, it is evident that the minimum amount produced by each of the animals was 2.3 kgm. and the maximum 14.1 kgm. The average daily yield for each horse varied from 6.0 to 6.6 kgm. In regard to the thirty-day production by each animal, the range was from an average of 182.6 to 199.1 kgm. During a period of 360 days the lowest yield from one horse was 2190.9 kgm., the highest collection from one horse was 2389.0 kgm., the average for all was 2311.7 kgm.

TABLE 4

Showing the relationship between the live weight and amount of fresh feces voided daily by Philippine horses

HORSES	AVERAGE WEIGHT	AVERAGE AMOUNT OF FECES VOIDED DAILY	AMOUNT OF FECES VOIDED DAILY PER 100 KGM. LIVE WEIGHT OF HORSES
	kgm.	*kgm.*	*kgm.*
Herd No. 2	237.0	7.3	3.08
Herd No. 4	230.4	9.5	4.12
Herd No. 10	216.4	6.0	2.77
Herd No. 18	231.4	6.5	2.81
Herd No. 20	251.9	5.2	2.06
Herd No. 26	253.6	6.5	2.56
Average	....	....	2.90

Relationship between the live weight and amount of fresh feces passed out daily

Table 4, giving the relationship between the live weight of the horse and the amount of feces voided daily, shows that the amount of feces defecated daily for every 100 kgm. live weight of the horse varied from 2.06 to 4.12 kgm. The average amount for all the horses was 2.90 kgm., which is equivalent to the percentage daily production on the basis of the live weight of the animal.

TABLE 5

Showing the average analysis of feces from Philippine horses

HORSES	NUMBER OF SAMPLES	MOISTURE	ASH	NITROGEN	P_2O_5	K_2O	CaO
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Herd No. 2....	14	73.39	4.59	0.27	0.55	0.11	——
Herd No. 10....	26	73.21	5.48	0.30	0.60	0.11	0.26[a]
Herd No. 18....	26	74.47	5.26	0.25	0.47	0.10	0.22[b]
Herd No. 20....	10	73.25	7.02	0.27	0.60	0.11	0.42
Herd No. 26....	25	75.00	4.87	0.29	0.61	0.10	0.17[c]
General average.	......	73.86	5.44	.28	.57	.11	.21

[a] Based on 13 samples.

[b] Based on 15 samples.

[c] Based on 14 samples.

Chemical analysis

Table 5 and 6 show a total of 101 samples of fresh feces from five horses which were analyzed for moisture, ash, nitrogen, phosphoric acid, calcium and potash. In the same tables are shown 42 samples of the same material from four horses with the determination for lime content.

Moisture. The general average percentage of moisture contained in fresh horse feces analyzed was found to be 73.86, the range of the averages for the different horses being from 73.21 to 75.00 per cent. The general average is slightly below 75 per cent, the figure reported by Van Slyke (1920.)

Ash. The variation in the amount of ash obtained from the feces was on an average from 4.59 to 7.02 per cent, the general average for all horses being 5.44 per cent.

Nitrogen. The general average percentage of nitrogen amounting to 0.28, is significantly lower than the average, 0.55 per cent, given by Van Slyke (1920). In this study the minimum percentage found was on an average, 0.25 and the maximum, 0.30 per cent; Van Slyke's figures are 0.50 per cent for the minimum and 0.60 per cent for the maximum.

Phosphoric acid. The lowest percentage of phosphoric acid contained in the feces from one horse was found to be an average of 0.47, and the highest was 0.61 per cent. Van Slyke's (1920) minimum and maximum percentages of this constituent are much lower, 0.25 and 0.30, respectively. The general average percentage of phosphoric acid found in this experiment, amounting 0.30 to 0.57 per cent, is correspondingly much higher than the average reported by Van Slyke.

TABLE 6

Showing the average percentage of phosphoric acid, potash and lime in the ash of feces of Philippine horses

HORSES	NUMBER OF SAMPLES	P_2O_5	K_2O	CaO
		per cent	*per cent*	*per cent*
Herd No. 2	14	11.94	2.53	——
Herd No. 10	26	11.47	2.38	4.43[a]
Herd No. 18	26	8.57	2.09	4.29[b]
Herd No. 20	10	8.47	1.74	5.36
Herd No. 26	25	12.45	2.31	3.38[c]
General average		10.58	2.21	4.37

[a] Based on 13 samples.

[b] Based on 15 samples.

[c] Based on 14 samples.

Potash. In the case of this constituent, the general average found in the feces of Philippine horses, amounting to 0.11 per cent, is much below the average, 0.40 per cent, given by Van Slyke (1920). The range in the average percentage amount of this substance in the feces was from 0.10 to 0.11, whereas Van Slyke's figures vary from 0.30 to 0.50 per cent.

Lime. The minimum average of this material found in the feces of one horse was on the average, 3.38 per cent, and the maximum amount was 5.36 per cent. The general average content in the ash of feces from all horses was 4.37 per cent.

AMOUNT AND VALUE OF FERTILIZERS OBTAINABLE FROM FECES ANNUALLY[2]

With the average yearly production of 2311.7 kgm. of feces per horse, as a base, the amount of the different fertilizers that may be expected from it, according to chemical analysis, is as follows: Nitrogen, 6.47 kgm.; phosphoric acid, 13.18 kgm.; potash, 2.54 kgm.; lime, 101.02 kgm.

Taking as a base for computation one metric ton of sulfate of ammonia, BASF brand valued at ₱110, and containing a guaranteed minimum of 20.6 per cent of nitrogen, the value of 6.47 kgm. of nitrogen is ₱3.45. With superphosphate containing 19 per cent of phosphoric acid and valued at ₱50 per metric ton the value of 13.18 kgm. of phosphoric acid is ₱3.47.

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[2] Fertilizer quotations obtained from Menzi and Co., Inc., Manila, as of December 6, 1930.

Taking as a base muriate of potash containing 50 per cent of potash and valued at ₱150 per metric ton, the value of 2.54 kgm. of potash is ₱0.76. Thus, the total value of fertilizers that may be obtained from a year's production of feces from one horse is ₱7.68.

SUMMARY OF RESULTS

1. Philippine horses voided solid excreta on an average of 7.7 times during 24 hours.

2. The range in the daily amount of solid excreta voided by each horse was from 2.3 to 14.1 kgm.

3. The average daily yield of feces excreted by each horse varied from 6.0 to 6.6 kgm.

4. The thirty-day production of feces from each horse averaged from 182.6 to 199.1 kgm.

5. The yield of feces during a period of 360 days from each animal ranged from 2190.9 to 2389.0 kgm. The average yield for all the horses was 2311.7 kgm. per animal.

6. The amount of feces defecated by the horses was on an average 2.9 per cent of their live weight.

7. The average composition of fresh feces of horses is as follows:

	per cent
Moisture	73.86
Ash	5.44
Nitrogen	0.28
Phosphoric acid (P_2O_5)	0.57
Potash (K_2O)	0.11
Lime (CaO)	0.21

8. The average composition of the ash of fresh feces of horses is as follows:

	per cent
Phosphoric acid	10.58
Potash	2.21
Lime	4.37

9. The average yearly production of fertilizers from one horse is as follows: Nitrogen, 6.47 kgm.; phosphoric acid, 13.18 kgm.; potash, 2.54 kgm.; lime, 101.02 kgm.

10. A total of ₱7.68 may be derived from the different fertilizers obtainable from the feces yielded by one horse annually, distributed as follows: Nitrogen, ₱3.45; phosphoric acid, ₱3.47; potash, ₱0.76.

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A CRITICAL STUDY OF THE NUTRITIVE VALUES OF NITRATE NITROGEN FOR YOUNG RICE PLANTS[1]

R. B. ESPINO AND ROMAN P. ESTIOKO
Of the Department of Plant Physiology

WITH FIVE TEXT FIGURES

For most of the higher plants, nitrogen is best supplied in the form of nitrates. When nitrogen is present, however, in a complete culture solution only as nitrate, Espino (1920) found that the solution failed to produce a normal growth and development of young rice plants. A complete culture solution containing (in addition to a trace of iron phosphate), monopotassium phosphate, calcium nitrate, and magnesium sulfate, in any proportion and concentration, was harmful to the young plants. Excellent growth was obtained with proper sets of salt proportion when, to the salts mentioned above, ammonium sulfate was added. This suggests that the plants required the ammonium ion.

Results of several experiments have shown conclusively that the ammonium ion is indispensable for young rice plants. In addition to ammonium sulfate which was found by Espino to be good for this plant, the phosphate and the nitrate of ammonium were found by Espino and Palisoc (1927) also to be good or suitable. In fact, experiments conducted in this laboratory produced results showing that the nitrate of ammonium was better than any of the other compounds of ammonium tried. This result suggests that the presence at the same time of the ammonium and the nitrate ions in the culture medium is better for the young rice plant than when either of the two ions is present alone. Acting on this supposition, Espino tried to eliminate nitrate nitrogen from the medium. He replaced calcium nitrate with monocalcium phosphate [$Ca(H_2PO_4)_2H_2O$]. The culture solution thus formed contained monopotassium phosphate, monocalcium phosphate, ammonium sulfate and magnesium sulfate, and the usual trace of iron.

Several proportions of these salts were tried. Various concentrations of the culture medium were tried. The best solutions in this nitrate-free set gave about as good results as the best ones which contained both the ammonium and the nitrate ions. However, the nitrate-free culture media "always produced a marked and characteristic leaf injury, so that no solution of this type is to be regarded as at all suited to the growth of these

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plants". According to Espino this result "suggests that these young rice plants required (at least within the range of these experiments) not only the ammonium ion but also the nitrate ion".

The monocalcium phosphate, however, when used singly and compared with other salts of calcium, was found by Macasaet (1927) to be the most toxic. From Macasaet's report, the following is quoted:

> Of the different salts of calcium [$CaSO_4$, $Ca(H_2PO_4)_2H_2O$, $CaCl_2$, $Ca(NO_3)_2$, and $CaCO_3$], only the monobasic calcium phosphate [$Ca(H_2PO_4)_2H_2O$], was found extremely toxic. This salt produced decidedly stunted plants with leaves severely dried at or near the tips. The other salts were apparently beneficial, or nutritious.

The monocalcium phosphate was the salt that Espino employed. The other calcium salts tested in the present study had never been tried before. Suspicion may be entertained, then, that the failure to obtain normally developed young rice plants when the nitrate-free solutions were used might have been due to the severe toxic action of the monocalcium phosphate.

It was thought advisable to continue the study on the effect upon young rice plants of the absence of nitrates from complete culture media, and to use, (in addition to the monocalcium phosphate), other salts of calcium, preferably those that would not add to the culture medium any of the elements not essential for the normal growth and development of the higher plants. This was the object of this study.

The study was carried out in the experimental glass chamber of the Department of Plant Physiology of the College of Agriculture, from April 6, 1927 to August 27, 1927 covering a period of five months. In performing some of the experiments, the writers were assisted by Mr. Leopoldo Abes. Additional experimental data were gathered during the period from April 1 to August 28, 1928.

MATERIALS, METHODS, AND RESULTS

The plant

The plants were grown from seeds of rice, variety Roxas. As is customary, the seeds were germinated on a piece of paraffined bobbinet stretched over and touching the surface of water contained in a wide-mouthed glass jar. Five days after sprouting, seedlings were selected and fastened to cork stoppers in the manner described by Shive (1914). A seedling was inserted through each of the three holes in a cork stopper, so each culture had three small plants. These plants were supplied with the culture solutions listed in table 1. Each culture period lasted for thirty days and renewals of the culture solutions were made at intervals of every three days.

TABLE 1

Showing the proportion and concentration of the salts used in each culture medium. The concentration is in gram-molecule

CULTURE NO.	SALT PROPORTION			
	KH_2PO_4	Ca-salts	$(NH_4)_2SO_4$	$MgSO_4$
I	.0003	.000475 $[Ca(NO_3)_2]$	———	.001225
II	.00025	.000375 $[Ca(NO_3)_2]$	.000375	.001
III	.00025	.000375 $[Ca(H_2PO_4)_2.H_2O]$	.000375	.001
IV	.00025	.000375 $[Ca(HPO_4.2H_2O]$	.000375	001
V	.00025	.000375 $(CaSO_4)$	.000375	.001
VI	.00025	.000375 $(CaCl_2)$	.000375	.001
VII	.00025	.000375 $[Ca_3(PO_4)_2]$	.000375	.001

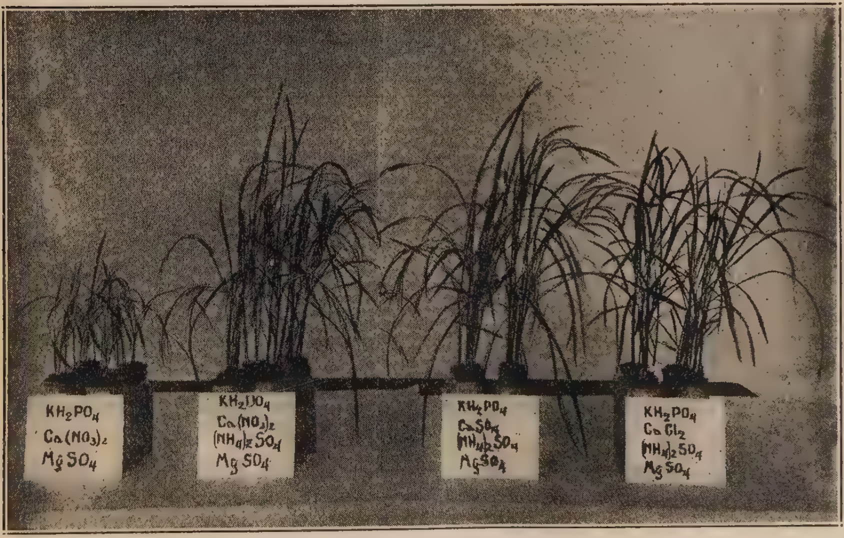
KH2PO4
Ca(NO3)2
MgSO4
KH2PO4
Ca(NO3)2
(NH4)2SO4
MgSO4
KH2PO4
CaSO4
(NH4)2SO4
MgSO4
KH2PO4
CaCl2
(NH4)2SO4
MgSO4

Fig. 1 —Appearance of the plants at the time of harvest. Numerical data are in table 2. Experiments were run from April 6 to May 6, 1927. The salts used in the culture are shown.

The culture solutions

Seven types of culture solutions were employed in this study. They were composed of salts in amounts or proportions and concentrations as shown in table 1. As in previous studies of similar nature, the single salt solutions were first prepared. The concentration of the solution depends upon the solubility of the salt. The salts required to make up each culture medium were mixed in the proportion shown in table 1 and in a manner described by Espino (1920). Iron was added to the culture solution as ferric phosphate[2].

Five sets of cultures were run in this study. These sets are here designated as trial 1, trial 2, trial 3, trial 4, trial 5. The first two trials had four cultures each, and the last three, seven. Each culture had three plants and was run in hexplicates. The cultures were examined from time to time. At the end of thirty days in the culture solutions, the plants were observed for the last time and the height of the tallest leaf in each culture was measured. Then the plants were harvested. The tops were severed from the roots. The tops and the roots were dried and their respective weights determined. The data thus obtained are recorded in separate tables. The results obtained from the cultures in each trial will be considered separately.

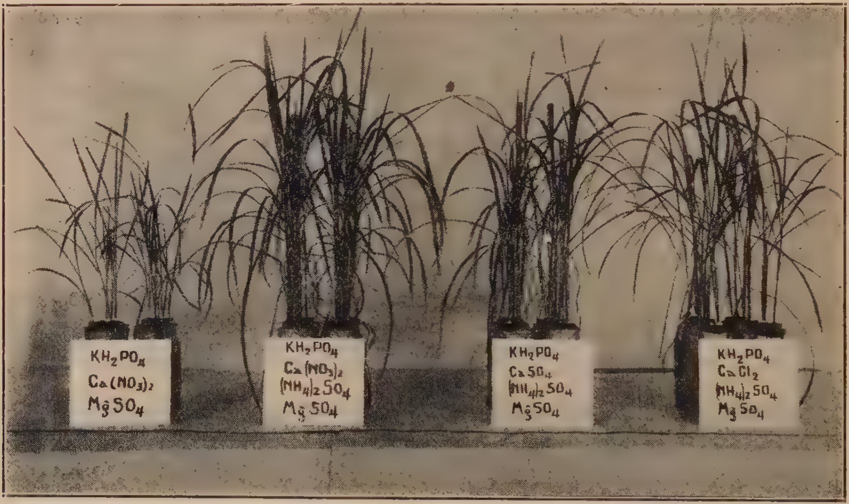
KH_2PO_4 $Ca(NO_3)_2$ $MgSO_4$
KH_2PO_4 $Ca(NO_3)_2$ $(NH_4)_2SO_4$ $MgSO_4$
KH_2PO_4 $CaSO_4$ $(NH_4)_2SO_4$ $MgSO_4$
KH_2PO_4 $CaCl_2$ $(NH_4)_2SO_4$ $MgSO_4$

Fig. 2 —Showing the plants as they were on June 8, 1927. Numerical data are in table 3. Experiments were run from May 8 to June 8, 1927. The salts used in culture media are shown.

Trial 1. The cultures in this trial were run from April 6 to May 6, 1927. They were of four types. As shown in table 1, culture I was of three-salt type. In this culture ammonium salt was not used. The three other types were of four-salt; each culture had four main salts. Except culture II, which had both the nitrate and the ammoniacal forms of nitrogen, the cultures had no nitrate at all. The $Ca(NO_3)_2$ which culture II originally contained was replaced in culture V by $CaSO_4$ and in culture VI by $CaCl_2$. At the end of the culture period, the plants were photographed (see fig. 1). The plants were then harvested, and the average height of the plants in the six similar cultures determined. The tops and the roots from each culture were separately dried and their dry weights determined. The external appearance of the plants was noted. The data which were obtained as averages of six similar cultures under these criteria are given in table 2.

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[2] The ferric phosphate was prepared as recommended by Livingston (1919).

TABLE 2

Showing data from the cultures in trial 1 obtained at the time of harvest

CULTURE NO.	AVERAGE HEIGHT OF PLANT	DRY WEIGHT (RELATIVE VALUES)[a]			APPEARANCE OF PLANT AT HARVEST
		Top	Root	Top and root	
	cm.				
I	18	21	27	22	Plants chlorotic, stunted in growth. Only two or three younger leaves living.
II	35	100 (.068 gram)	100 (.015 gram)	100 (.083 gram)	Plants normally developed; leaves green.
III	—	—	—	—	—
IV	—	—	—	—	—
V	36	93	87	92	Plants quite healthy, but leaves rather narrow.
VI	35	90	87	89	Plants quite healthy, but with lighter green leaves.
VII	—	—	—	—	—

Cultures III, IV and VII were not run.

[a] The highest *actual value* under each of the dry weight criteria was arbitrarily considered 100; the other actual values were relatively reduced. Only the *actual values* for 100 are recorded in the table, enclosed in parentheses. The *actual values* are averages of six similar cultures.

Trial 2. Cultures similar to those employed in trial 1 were run again, starting the experiments on May 9 and stopping on June 8, 1927. As in trial 1, the plants in trial 2 were photographed (see fig. 2). The dry weights of the tops, roots, and of the tops and the roots combined, were determined.

The data, thus gathered, as averages of six similar cultures, are given in table 3.

TABLE 3

Showing data from the cultures in trial 2, obtained at the time of harvest

CULTURE NO.	AVERAGE HEIGHT OF PLANT	DRY WEIGHT (RELATIVE VALUES)[a]			APPEARANCE OF PLANT AT HARVEST
	cm.	Top	Root	Top and root	
I	26	34	36	34	Plants chlorotic, stunted in growth. Tips of older leaves dried.
II	42	100 (.112 gram)	100 (.022 gram)	100 (.134 gram)	Plants normally developed; leaves broad and green.
III	—	—	—	—	—
IV	—	—	—	—	—
V	33	78	82	78	Plants fairly developed but leaves light green and dried at tips.
VI	36	76	64	74	Plants like those in culture 3.
VII	—	—	—	—	—

Cultures III, IV, and VII were not run.

[a] See footnote in table 2.

Trial 3. In order to make the results more conclusive, the four cultures tried in trials 1 and 2 were run again, and three other cultures in addition. In each of these new cultures the $Ca(NO_3)_2$ originally present in culture II was replaced by a form of phosphate of calcium. Culture III contained, in addition to other salts, monocalcium phosphate, $[Ca(H_2PO_4)_2.H_2O]$. Culture IV had the dicalcium phosphate, $(CaHPO_4.2H_2O)$, and culture VII was supplied with the tricalcium phosphate $[Ca_3(PO_4)_2]$. Under the criteria employed in the previous cultures, the data, as averages of six similar cultures, obtained from the seven types of cultures run from May 25 to June 25, 1927 for trial 3, are recorded in table 4. The plants were photographed at the end of the culture period (see fig. 3).

Trials 4 and 5. To find out if the results obtained from the previous cultures, particularly those from the trial 3, could be duplicated, sets of cultures here designated as trial 4 and trial 5, were run.

The cultures in trial 4 were conducted from June 15 to July 16, 1927. Photographs were taken, (see fig. 4). As usual, at the end of the experimental period, the plants were harvested and data were recorded. These data, as averages of six similar cultures, are recorded in table 5.

TABLE 4

Showing data from the cultures in trial 3, obtained at the time of harvest

CULTURE NO.	AVERAGE HEIGHT OF PLANT	DRY WEIGHT (RELATIVE VALUES)[a]			APPEARANCE OF PLANT AT HARVEST
		Top	Root	Top and root	
	cm.				
I	30	44	54	45	Plants chlorotic, stunted in growth. Older leaves dried.
II	39	100 (1.879 grams)	99	100 (2.242 grams)	Plants perfectly developed; green leaves.
III	34	58	61	59	Plants fairly normal; leaves pale green, and narrow. Older leaves almost dry.
IV	37	88	79	86	Plants pale green; leaves broad but older leaves dried at tips.
V	40	72	61	70	Plant normally green; older leaves dried at tips.
VI	40	84	91	85	Resembling the plants in V.
VII	39	83	100 (.365 gram)	85	Resembling the plants in III.

[a] See footnote in table 2. But the *actual values* are the sum of the dry weights from six similar cultures.

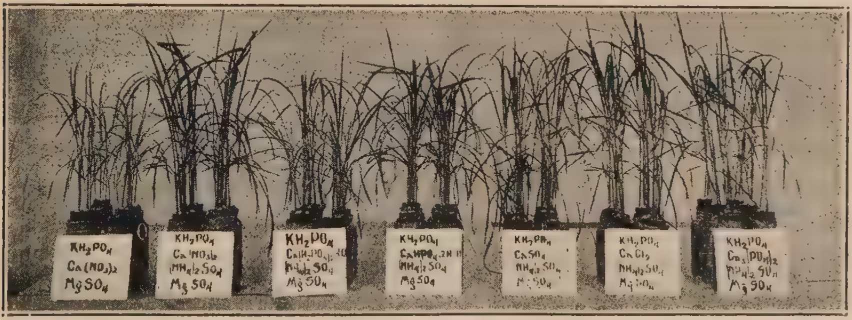
KH_2PO_4
$Ca(NO_3)_2$
$MgSO_4$
KH_2PO_4
$Ca(NO_3)_2$
$(NH_4)_2SO_4$
$MgSO_4$
KH_2PO_4
$Ca(H_2PO_4)_2$
$(NH_4)_2SO_4$
$MgSO_4$
KH_2PO_4
$CaHPO_4 \cdot 2H_2O$
$(NH_4)_2SO_4$
$MgSO_4$
KH_2PO_4
$CaSO_4$
$(NH_4)_2SO_4$
$MgSO_4$
KH_2PO_4
$CaCl_2$
$(NH_4)_2SO_4$
$MgSO_4$
KH_2PO_4
$Ca_3(PO_4)_2$
$(NH_4)_2SO_4$
$MgSO_4$

Fig. 3—Showing the plants as they appeared on June 25, 1927. Numerical data are in table 4. Experiments were run from May 25 to June 25, 1927. The salts used in culture media are shown.

The cultures in trial 5 were run from July 28 to August 27, 1927. At the time of harvest the plants were photographed, (see fig. 5). The experimental data gathered, as averages of six similar cultures, are recorded in table 6.

TABLE 5

Showing data from the cultures in trial 4, obtained at the time of harvest

CULTURE NO.	AVERAGE HEIGHT OF PLANT	DRY WEIGHT (RELATIVE VALUES)[a]			APPEARANCE OF PLANT AT HARVEST
		Top	Root	Top and root	
	cm.				
I	25	29	42	32	Plants chlorotic, stunted in growth. Older leaves dried.
II	43	100 (1.51 grams)	100 (.282 gram)	100 (1.792 grams)	Plants perfect; leaves green.
III	38	53	61	54	Plants tall; but with pale green leaves dried at tips.
IV	42	90	85	89	Plants tall; but leaves pale green dried at tips.
V	38	75	69	74	Plants fairly normal; but with some older leaves dried at tips.
VI	40	85	85	85	Same as V.
VII	40	85	78	84	Plants almost normal; leaves green but a few older leaves dried at tips.

[a] See footnote in table 2. But the *actual values* are the sum of the dry weights from six similar cultures.

DISCUSSION OF RESULTS

In comparing the relative nutritive values of the different culture solutions employed in this study with the object of determining particularly the behavior of the young rice plants when grown in the nitrate-free media, the external appearance of the plants is considered as the most important and the deciding criterion. This plan was followed because of the fact that, excepting culture I in which all the plants were stunted, the plants in the other types of cultures were more or less similarly well developed. The plants may therefore have the same or similar dry weights but may differ in the presence or absence of certain characteristic physiological injuries. Drying of leaves or of leaf tips in some of the cultures were observed. The data under the other criteria are here considered as only supplementing those obtained under the criterion, external appearance of the plants.

TABLE 6

Showing data from the cultures in trial 5, obtained at the time of harvest

CULTURE NO.	AVERAGE HEIGHT OF PLANT	DRY WEIGHT (RELATIVE VALUES)[a]			APPEARANCE OF PLANT AT HARVEST
		Top	Root	Top and root	
	cm.				
I	25	32	37	33	Plants chlorotic and stunted in growth; leaves narrow and dried at tips.
II	40	100 (1.224 grams)	100 (.265 gram)	100 (1.489 grams)	Plants normally developed; leaves green and no sign of injury.
III	30	52	46	51	Leaves pale green, dried at tips.
IV	33	79	84	80	Plants normally developed but not as good as those in II. Tips of few leaves dry.
V	31	68	86	71	Similar to plants in IV.
VI	33	76	87	78	Plants almost as good as those in II but tips of a few leaves dried.
VII	33	79	95	82	Plants green, leaves broad. Tip of older leaves dry.

[a] See footnote in table 2. But the *actual values* are the sum of the dry weights from six similar cultures.

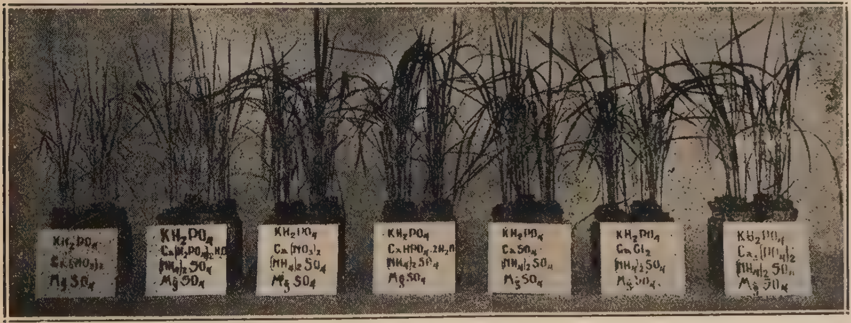
KH_2PO_4 $Ca(NO_3)_2$ $MgSO_4$
KH_2PO_4 $Ca(H_2PO_4)_2.H_2O$ $(NH_4)_2SO_4$ $MgSO_4$
KH_2PO_4 $Ca(NO_3)_2$ $(NH_4)_2SO_4$ $MgSO_4$
KH_2PO_4 $CaHPO_4.2H_2O$ $(NH_4)_2SO_4$ $MgSO_4$
KH_2PO_4 $CaSO_4$ $(NH_4)_2SO_4$ $MgSO_4$
KH_2PO_4 $CaCl_2$ $(NH_4)_2SO_4$ $MgSO_4$
KH_2PO_4 $Ca_3(PO_4)_2$ $(NH_4)_2SO_4$ $MgSO_4$

Fig. 4.—Showing the plants as they appeared on July 16, 1927. Numerical data are in table 5. Experiments were run from June 15 to July 16, 1927. The salts used in culture media are shown.

The NH_4-free cultures

Invariably the plants in culture I, in which the plants were supplied with nitrogen only as nitrate, were chlorotic and decidedly stunted (see tables 2 to 6 and fig. 1 to 5, inclusive). This result further confirms previous results reported by Espino on similar cases to the effect that nitrate-nitrogen when present alone in complete culture media is inadequate to produce a normal growth and development of young rice plants.

Cultures containing NH_4—and NO_3–nitrogen

Under almost all the criteria here employed (see tables 2 to 6), particularly those on the external appearance of the plants (see fig. 1 to 5, inclusive), culture II, in which the plants were supplied with nitrogen both as ammoniacal and as nitrate, always produced well developed plants. This culture was superior to any of the other cultures employed in this study. This result confirms once more what has been reported by Espino on the subject—that the young rice plants require for their normal growth and development a certain amount of ammoniacal nitrogen in complete culture solutions. It brings up again the question as to whether or not young rice plants would develop normally in complete culture solutions in which nitrate-nitrogen is eliminated. This question was partially answered by results reported by Espino in 1920 and is conclusively answered by results obtained from the present study.

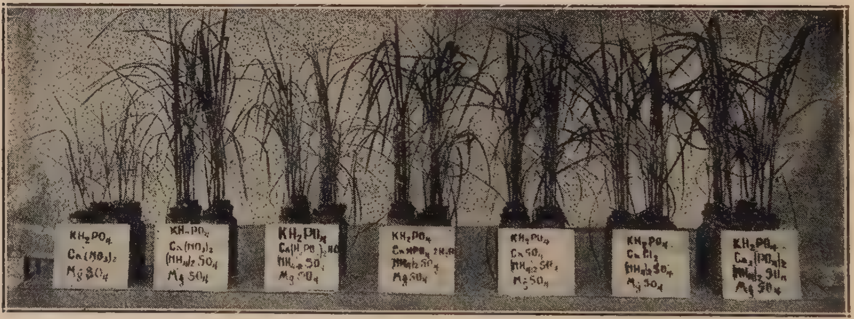

Fig. 5.—Showing the plants as they appeared on August 27, 1927. Numerical data are in table 6. Experiments were run from July 28 to August 27, 1927. The salts used in culture media are shown.

The NO_3–free cultures

As shown in table 1 and explained elsewhere in this paper, the $Ca(NO_3)_2$ originally contained in culture II was replaced by each of the calcium salts,—$Ca(H_2PO_4)_2.H_2O$, $CaHPO_4.2H_2O$, $CaSO_4$, $CaCl_2$ and $Ca_3(PO_4)_2$. This substitution produces culture solutions each of which contains all the essential elements which are generally obtained by the green plants from the soil, but without any nitrate. The results from these nitrate-free cultures (cultures III to VII, inclusive) are here discussed as follows:

External appearance of the plants. An important result not recorded in any of the tables in this paper is that the plants in all the cultures (excepting culture I), during the first fifteen days in the culture solutions, were fairly uniform in growth and development. The plants were green and showed no apparent sign of physiological disturbance. The absence of nitrate-ion from the culture media in which ammonium was present gave no apparent harmful effects upon the young plants at this age. However, as the plants grew older they began to show signs of injury, such as drying of older leaves and of the tips of even medium-aged leaves. The injury became most pronounced at the time of harvest, that is, at the end of thirty days in the culture solutions, (see tables 3 to 6, inclusive) and it would probably have been more apparent if the cultures had been run longer. On the other hand, the plants which were grown in the culture solution (culture II) containing both ammonium and nitrate, were normal. They showed no sign of any physical injury. It is therefore evident, that nitrate-ion is essential for the growth of the young plants when ammonium ion is present in the culture solution. It is likewise evident that the drying of the tips of leaves of rice reported by Espino in 1920 when only the $Ca(H_2PO_4)_2.H_2O$ was employed to replace $Ca(NO_3)_2$ in a complete culture solution, was not necessarily or exclusively due to the use of this salt but to the absence of nitrate-ion from the culture medium. It should, however, be admitted that of all the nitrate-free cultures tried, that which was supplied with the $Ca(H_2PO_4)_2.H_2O$ appeared to produce the most severe physical injury, (see tables 3 to 6 inclusive and culture III in fig. 1 to 5). The effects upon the young plants of any of the other nitrate-free solutions were more or less the same.

Dry weight of plants. The dry weight of plants grown in the nitrate-free solutions were lighter, except the one case on roots, (table 4), than those which were supplied with nitrogen both in ammoniacal and nitrate forms. These results were to be expected because the drying of older leaves in some cultures and the drying of the leaf tips in others must necessarily have interfered with the transpiration and photosynthesis of the young plants. Moreover, as dry leaves and dry leaf tips could no longer grow, they could cause no further increase in dry weight of the plants. This decrease in dry weights of the nitrate-free plants further corroborates previous findings on the subject, to the effect that the absence of nitrate-nitrogen from culture medium in spite of the presence of ammonium is harmful to young rice plants. Conversely, the presence of nitrate-nitrogen in a complete culture medium when ammonium is also present is essential for growth and development of the plants.

Height of tops. As shown in tables 2 to 6 inclusive and by the illustrations, the plants which were supplied with nitrogen only as nitrate (culture I) were always the shortest. The plants in the cultures (culture II), in which nitrogen was supplied as ammonium and nitrate together were in general, the tallest. The plants from the nitrate-free cultures, except those which were supplied with the monocalcium phosphate (culture III) were as tall or almost as tall as those from culture II. It may then be concluded that the absence of nitrate-nitrogen from the culture medium when ammonium is present does not materially interfere with the growth in height of young rice plants. However, the absence of nitrate always produced an injury,—drying of some leaves and leaf tips.

ADDITIONAL EXPERIMENTAL DATA

It was pointed out to the writers that while the results of the experiments just described seem to show that the rice plant cannot thrive without ammonium, yet it has not been established beyond doubt that the presence of a nitrate is absolutely essential for the best growth of the rice plant. With culture II, which gave the best growth, it was pointed out that it had nearly double the amount of nitrogen of any of the other cultures, and that about one-half of this nitrogen was in the nitrate form. It seemed quite probable that this best growth obtained from the sets of cultures just described was due to the double amount of nitrogen and not to the presence of a nitrate.

TABLE 7

Showing the salt contents of the cultures used in obtaining the data in table 9

CULTURE NO.	SALT CONTENTS	CULTURE NO.	SALT CONTENTS
I	2.5 cc. M/10 KH_2PO_4 7.5 cc. M/10 $Ca(NO_3)_2$ 10.0 cc. M/10 $MgSO_4$	V	2.5 cc. M/10 KH_2PO_4 37.5 cc. M/100 $CaSO_4$ 3.75 cc. M/10 $(NH_4)_2SO_4$ 10.00 cc. M/10 $MgSO_4$
11	2.5 cc. M/10 KH_2PO_4 3.75 cc. M/10 $Ca(NO_3)_2$ 3.75 cc. M/10 $(NH_4)_2SO_4$ 10.00 cc. M/10 $MgSO_4$	V-D	2.5 cc. M/10 KH_2PO_4 37.5 cc. M/100 $CaSO_4$ 7.5 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$
III	2.5 cc. M/10 KH_2PO_4 375.0 cc. M/1000 $Ca(H_2PO_4)_2.H_2O$ 3.75 cc. M/10 $(NH)_2SO_4$ 10.0 cc. M/10 $MgSO_4$	VI	2.5 cc. M/10 KH_2PO_4 3.75 cc. M/10 $CaCl_2$ 3.75 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$
III-D	2.5 cc. M/10 KH_2PO_4 375.0 cc. M/1000 $Ca(H_2PO_4)_2.H_2O$ 7.5 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$	VI-D	2.5 cc. M/10 KH_2PO_4 3.75 cc. M 10 $CaCl_2$ 7.5 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$
IV	2.5 cc. M/10 KH_2PO_4 375.0 cc. M/1000 $CaHPO_4 .2H_2O$ 3.75 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$	VII VII	2.5 cc. M/10 KH_2PO_4 375.0 cc. M/1000 $Ca_3(PO_4)_2$ 3.75 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$
IV-D	2.5 cc. M/10 KH_2PO_4 375.0 cc. M/1000 $CaHPO_4 .2H_2O$ 7.5 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$	VII-D	2.5 cc. M/10 KH_2PO_4 375.0 cc. M/1000 $Ca_3(PO_4)_2$ 7.5 cc. M/10 $(NH_4)_2SO_4$ 10.0 cc. M/10 $MgSO_4$

Because of these comments, it was thought best to amplify this study. Additional cultures were made in which the objections which had been raised were sufficiently considered. The culture media used were those the salt proportions of which are shown in table 7. Except culture I, III-D, IV-D, V-D VI-D, and VII-D, the culture media were exactly the same as those listed in table 1.

The experimental procedure followed in securing the additional experimental data was similar to that described for the preceding experiments. Some of the data obtained together with the culture media tested are shown in table 8. The data in this table confirm absolutely the results previously discussed. They show beyond question that a complete culture medium supplied with nitrogen only as a nitrate cannot produce normally developed young rice plants. That ammonium salt is indispensable for this plant was sufficiently shown also in these cultures. It is likewise shown that in culture media in which nitrogen was derived only from $(NH_4)_2SO_4$, the plants produced were always rather tall, apparently well developed, but some of the leaves and leaf tips were dry. This result also confirms those obtained from similar experiments described elsewhere in this paper.

Turning our attention to the last set of experiments, the results of which are shown in table 9. The data in table 9 also show that the nitrate alone in a complete culture solution was not able to produce well developed young rice plants. However, with the addition of an ammonium salt, the young plants became well developed and had broad green leaves. But when the nitrate was eliminated or not supplied, and $(NH_4)_2SO_4$ was the only source of nitrogen, the young rice plants, although apparently tall and green, produced rather narrow leaves, some of which soon became dry, while others remained green but with a characteristic drying of many of the leaf tips. This drying of the leaf tips is a physiological disturbance. It was observed present even in cultures III-D, IV-D, V-D, VI-D and VII-D in each of which the amount of ammonium salt, [$(NH_4)_2SO_4$, 7.5 cc. M/10, or 0.00075 gram-molecule] was equal to the combined amounts of the nitrate salt and ammonium salt in culture II, which produced well developed plants, with broad green leaves and no dried leaf tips. In culture II, the salt-carriers of nitrogen were 3.75 cc. M/10 $Ca(NO_4)_2$, or an equivalent of 0.000375 gram-molecule, and 3.75 cc. M/10 $(NH_4)_2SO_4$, or 0.000375 gram-molecule. Therefore, in view of the results obtained from the experiments described in the preceding paragraphs, it is established beyond any reasonable doubt that both ammonium and nitrate are essential for the normal development of the young rice plant, although the absence of a nitrate from a complete culture medium was not as seriously felt, or was not as harmful, as when the amonium salt was absent.

TABLE 8

Showing data from the cultures in trial 6, obtained at the time of harvest. The data under criteria on height of top and dry weight of top, root, and top and root are in relative values. Data under a were from cultures for March 15 to April 16, 1928, and those under b were from cultures for April 1 to May 4, 1928

CULTURE NO.[a]	CULTURE BOTTLE.[b]	Height of top		DRY WEIGHT						EXTERNAL APPEARANCE OF PLANTS
				Top		Root		Top and root		
		a	b	a	b	a	b	a	b	
I	1	56	53	21	16	11	22	19	17	(a) Plant stunted, leaves chlorotic, first and second leaves almost entirely dried. (b) Plant stunted and with chlorotic leaves. Several old leaves dried.
	2	48	52	11	13	5	20	9	14	
	3	52	59	12	8	7	18	11	9	
II	1	94	98	87	99	63	89	82	98	(a) Plants normally developed, with broad leaves. Best looking plants in the set. (b) Plants normally developed with broad green leaves.
	2	96	99	73	100 (0.327 gram)	47	71	68	97	
	3	93	97	100 (0.49 gram)	99	100 (0.126 gram)	100 (0.045 gram)	100 (0.616 gram)	100 (0.37 gram)	
III	1	84	81	43	52	36	49	41	52	(a) Plants poorly developed; leaves slightly chlorotic; two to four leaves dried at tips. (b) Plant slightly pale green, culms smaller, three leaves of each plant dried; other leaves dried at tip except the youngest.
	2	73	89	41	43	37	44	41	43	
	3	80	87	45	56	34	60	43	57	
IV	1	81	86	59	57	46	60	56	58	(a) Plants as poorly developed as those in culture III, except less drying of leaf tips. (b) Degree of drying of leaves much less than those in culture III; stems better developed.
	2	73	96	49	59	39	64	46	60	
	3	100 (29.7 cm.)	92	52	61	40	73	49	63	
V	1	84	100 (28.3 cm.)	52	64	44	64	50	65	(a) Plants as poorly developed as those in cultures III and IV, except less drying of leaf tips.
	2	79	89	52	63	43	56	50	62	(b) Plants similar to those in culture IV, but two leaves from each plant entirely dried.
	3	78	89	53	70	60	60	54	69	
VI	1	85	82	54	60	41	44	51	59	(a) Plants similar to the plants in culture V; leaves slightly chlorotic. (b) Plants similar to those in culture V; leaves slightly chlorotic
	2	79	76	51	57	36	58	48	58	
	3	88	89	51	52	39	44	48	51	

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[a] These culture designations correspond to those shown in table 7.

[b] There were three plants in each culture bottle.

TABLE 9

Showing data as relative values obtained from cultures when the amount of ammonium sulfate used was increased. Cultures were conducted from July 28, to August 28, 1928

CULTURE NO.[a]	LENGTH OF LEAVES	LENGTH OF ROOTS	DRY WEIGHT OF TOP	DRY WEIGHT OF ROOT	DRY WEIGHT OF TOP AND ROOT	EXTERNAL APPEARANCE OF PLANTS
I	24	85	14	21	15	Plants extremely stunted with chlorotic leaves and undeveloped root system.
II	98	78	90	100 (0.058 gram)	93	Plants well developed with broad green leaves.
III	71	70	47	45	47	Rather tall plants but leaves narrow; two or three of the oldest leaves were drying. Roots fairly developed.
III-D	66	74	47	46	48	Plants similar to those in culture III.
IV	100 (382 cm.)	82	100 (0.404 gram)	86	100 (0.454 gram)	Plants fairly well developed but showed the characteristic drying of tips of some leaves.
IV-D	88	79	77	57	76	Plants slightly inferior in development to those in culture IV with dried leaf tips.
V	70	73	50	48	51	Plants although fairly tall showed drying of some leaves and leaf tips.
V-D	82	83	61	53	61	Plants slightly better looking than those in culture V but also showing drying of some leaves and leaf tips.
VI	88	80	60	62	61	Plants fairly good looking but leaves narrow and some had dried leaf tips. Roots well developed.
VI-D	65	83	50	50	51	Plants poorly developed; oldest and medium aged leaves entirely dry; other leaves dry at tips.
VII	75	98	55	57	57	Plants similar to those in culture VI, some of older leaves were dry at tips; younger leaves were chlorotic.
VIII-D	82	100 (19.4 cm.)	81	74	81	Plants rather vigorous but the leaves were narrow and showed the characteristic drying of leaf tips.

[a] These culture designations correspond exactly to those shown in table 7 and their salt contents may be seen in that table.

SUMMARY AND CONCLUSIONS

1. It is established beyond question that nitrate-nitrogen in a culture medium is essential for normal growth and development of young rice plants that are about fifteen days old or older, but not for younger plants. The absence of nitrate from complete culture media produced young rice plants with leaves dried at or near the tips.

2. A complete culture solution containing nitrogen only as nitrate proved to be inadequate for young rice plants. The plants were stunted in growth and extremely chlorotic.

3. Nitrogen when present in a complete culture solution only as ammonium likewise proved inadequate for young rice plants.

4. Nitrogen when present in a complete culture medium both as nitrate and as ammonium proved in all cases beneficial to the young plants.

5. Of the calcium salts tried, the monobasic calcium phosphate was found to be the most toxic to the plants.

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THE PHOSPHORUS AND CALCIUM CONTENT OF SOME PHILIPPINE FOOD PRODUCTS[1]

F. T. ADRIANO AND M. S. DE GUZMAN

It is now known that deficiency of certain mineral elements in the diet is the cause of some physiological disturbances. In very serious cases these disturbances result in death. The experiment of Forster[2], a German physiologist, supports fully this statement. He fed a set of animals on a diet containing no mineral matter. After a few days all the animals died. According to Forster the animals will live longer if given no food at all than when fed food devoid of mineral matter.

Biochemists also have found that many maladies may be corrected by supplying mineral salts found to be deficient in the diet.

The organic constituents of food are used chiefly to supply energy and heat to the body, and as a source of building materials. To again cite Forbes (1909), the mineral elements have the following specific functions:—

(1) To form the essential structures of the body.
(2) To carry away gaseous products.
(3) To maintain neutrality and, if necessary, acidity or alkalinity of the digestive juices and other secretions.
(4) To control both voluntary and involuntary muscles.
(5) To cause the movements of liquids throughout the body and its tissues.
(6) To stimulate vital reactions.
(7) To assist in the coagulation of blood.
(8) To keep in solution certain of the nitrogenous constituents of the body.
(9) To aid in the digestion of proteins and fats.

From this list of functions the importance of the determination of the mineral constituents in foods is apparent. In Germany and Denmark, and in the United States and Hawaii the importance of mineral elements in the diet is widely recognized. Many workers, as Forbes (1909)[3], Forbes and Keith (1914)[3], Clark (1925)[4], Kelley, (1912)[4], Sherman (1919), and others, have made studies on the nutrition of the peoples of several places.

In the Philippines little, as yet, has been done on the subject of nutrition. Among the recent workers on the determination of some of the inorganic constituents in Philippine foods are Wells, Agcaoili, and Feliciano (1922) who analyzed the phosphorus content of 23 varieties of Philippine rice;

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[1] Experiment station contribution No. 719. Received for publication, February 10, 1931.

[2] *Cited* by Forbes (1909).

[3] *Cited* by Acosta (1928).

[4] *Cited* by Severino (1928).

Adriano and Tavanlar (1925) who determined the calcium oxide content of some Philippine foods; Severino (1928) who worked on the manganese, calcium, and magnesium contents of some Philippine foods and feeding stuffs; and Acosta (1928) who studied the sodium, potassium and phosphorus contents of some Philippine foods and feeding stuffs.

Roxas (1922) asserted that the Filipino dietary may be deficient in calcium as well as vitamins and proteins.

Phosphorus compounds are as widely distributed in the body and are as strictly essential to every living cell as are proteins (Sherman, 1919). According to Forbes and Keith[5], among the several inorganic elements involved in animal life, phosphorus is of special interest. No other inorganic element enters into such a diversity of compounds and plays an important part in so many functions. Structurally, it is important as a constituent of every cell nucleus and of all cellular structures; it is also prominent in the skeleton, in milk, in sexual elements, glandular tissues, and the nervous system. Functionally, it is involved in all cell multiplication, in the activity and control of enzyme actions, in the maintenance of neutrality in the organism, and in the conduct of nerve stimuli. Through its relation to osmotic pressure, surface tension, and imbibition of water by colloids, it has to do with movements of liquid, with the maintenance of proper liquid contents of the tissues, with cell movements, and with absorption and secretion.

Sherman, Metler, and Sinclair (1910) found that the body needs about 3. 5 grams phosphorus a day. This amount is in agreement with the estimate of Langworthy, (1907).

Amount of mineral salts required per man per day

Phosphorus	3.0	to	4.0	grams
Sulphur	2.0	to	3.5	grams
Potassium	2.0	to	3.0	grams
Calcium	0.7	to	1.0	grams
Magnesium	0.3	to	0.5	grams
Iron	0.006	to	0.012	grams
Chlorine	6.0	to	8.0	grams

Voit[6] found that the bones contain a large proportion of the total phosphorus of the body. According to his estimate, a man's skeleton contains about 600 grams of phosphorus: his muscles, about 56 grams, his brain and nerves about 5 grams.

In relation to development and growth of the body, Sherman (1919) gives the following:

> Bone development may also be interfered with by inadequacy of the phosphorus supply. Several investigators, in studying the effects of diet upon growth of bone, have found that

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[5] *Cited* by Sherman (1919).

[6] *Cited* by Sherman (1919).

> the bones formed in a young animal kept on phosphorus poor diet are apt to be soft, spongy, and weak (of low breaking strength), and that this may be prevented by the simple addition of calcium phosphate to the food.
>
> Since phosphorus is a prominent constituent not only of bones but of all the soft tissues as well, the effects of a phosphorus deficiency may be far reaching. In the experiments of Hart, McCollum, and Fuller, young pigs on phosphorus poor food continued to grow for some time but finally developed not only the bone defects just noted but also weakness of the legs, stupor, and a more or less comatose condition accompanied by twitching of the muscles, dragging of the hind quarters, and ultimately loss of weight and collapse. These effects were all prevented by simple addition of calcium phosphate to the food.

Henry and Morrison (1917) also observed that animals that have been fed with food deficient in phosphorus have brittle and small bones. They also noted that young growing animals require a greater amount of phosphorus than the mature individuals.

Sherman (1919) estimated that about 85 per cent of the mineral matter of bone, or at least three-fourths of the entire ash of the body consists of calcium phosphate And that probably over 99 per cent of the calcium in the body belongs to the bones, the remainder occurring as an essential constituent of the tissues and body fluids. He says that calcium salts are necessary to the coagulation of the blood and in regulating the action of heart muscles.

Voit[6] in studying the effects of insufficient calcium kept a bird for a year on calcium poor food. Externally, there were no signs of any effects of the diet, but a post-mortem examination revealed perforations in the bones of the skull and sternum caused by the draining of calcium salts from those parts.

Quoting Sherman (1919), "abnormal weakness and flexibility of the bones, resembling the condition of rickets in children, has been produced experimentally by feeding puppies with lean and fat meat only, while others of the same litter, receiving the same food, but with the addition of bones to gnaw, developed normally." Hester, as cited by Sherman, (1919) thinks that an underlying cause of many cases of arrested development in infancy, is the insufficient assimilation of calcium, and many medical writers have attributed different diseases to inadequate calcium supply, or disturbance of calcium metabolism.

Sherman (1919) says further that with approaching maternity, the calcium requirement of a woman should be increased to meet the needs of the rapidly growing skeleton of the infant. This extra calcium in the diet should normally be maintained for several months after the child is born as its calcium demand is satisfied through the mother. Bungs, cited by Sherman (1919), believes that the weakening of the bones and teeth of a pregnant and lactating mother is attributable "to a withdrawal of calcium from these structures to meet the nutritive requirements of the embryo or the nursling." In this connection Sherman (1919) cited Lusk who emphasized that pregnant women should be fed on a diet rich in calcium to meet the rapid storing of calcium by the fetus, especially during the last ten days before parturition.

Forbes (1919) recommends that the giving of food rich in calcium should be continued even after the cessation of lactation, to replace the calcium which the mother has lost.

The experiments of Steenbock and Hart, as cited by Sherman (1919), show that the production of milk in cows and goats causes a heavy drain upon the calcium of the skeleton unless the amount of calcium contained in the food be very abundant.

Henry and Morrison, as cited by Severino (1928), state that farm animals fed with feeds grown in calcium deficient soils may have bones that are so brittle that they break very easily.

Having emphasized the functions of calcium in the body, one must not overlook the calcium requirement of the body. Various opinions are given on this subject. Langworthy, as cited by Acosta (1928), states that a man requires from 0.7 t 1.0 grams of calcium a day. Lusk (1917) states that according to German authorities, a man should have 1.5 grams of calcium daily, while the standard set by Harneman, as cited by Tavanlar (1925), places it at from 0.4 to 1.0 gram. Other workers vary in their standards. In the Philippines, Roxas (1928) reported that the average calcium intake per man a day of three Filipino families was 0.1274 gram.

OBJECT OF THE PRESENT WORK

With the hope of facilitating the work of future investigators along dietary studies this investigation was undertaken. The object was to determine the total phosphoric acid, anydride and calcium oxide contents of some of the most common Philippine food products available during the period of the study.

MATERIALS AND METHODS

Most of the materials analyzed were ashes of the samples which were used by the junior author in the study of the proximate chemical analysis of some Philippine food products while a student in the College of Agriculture. The samples (see table) were purchased in the Los Baños, Calamba, Cavite, and Manila markets.

EXPERIMENTAL

In procuring the materials, care was used to secure a representative sample. A small representative sample was taken from the purchased materials. For the determinations of phosphoric acid and calcium oxide, the samples were taken from the ashes of the food products studied. Determinations were based on the edible portions of the materials.

With slight modifications, the methods of analysis followed were those adopted by the Association of Official Agricultural Chemists. (1925).

RESULTS

The results are given in table 1. The percentages of the constituents reported are the averages of two concordant determinations.

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TABLE 1

Showing the phosphoric acid, anhydride and calcium oxide content of some Philippine food products

PRODUCTS ANALYZED	MOISTURE	ASH	PHOSPHORIC ACID IN			CALCIUM OXIDE IN		
			Ash	Dry material	Sample analyzed	Ash	Dry material	Sample analyzed
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Cereal and bean products								
1. Bihon[a], noodles made from rice (*Oryza sativa* Linn.) flour	9.51	0.72	10.31	0.08	0.07	4.82	0.03	0.03
2. Mique, noodles made from wheat (*Triticum vulgare* Vill.) flour, brine solution, and alkali water	45.42	3.16	1.74	0.10	0.05	1.25	0.07	0.03
3. Miso, soybean (*Glycine hispida* Maxim.) mush	69.56	2.19	13.95	0.97	0.30	7.49	0.53	0.16
4. Misua, noodles made from wheat flour and salt water	10.49	6.10	5.58	0.37	0.34	3.20	0.21	0.01
5. Pidios, noodles made from high quality and highly glutinous rice flour (artificially colored yellow)	10.03	0.34	42.72	0.15	0.14	7.65	0.28	0.02
6. Sutanghon, noodles made from rice flour, (uncolored, partly transparent and twisted)	10.33	0.91	27.35	0.27	0.24	23.90	0.24	0.21
7. Tahuri, soybean curd, preserved in strong brine solution (solid portion)	58.41	19.15	10.92	0.50	0.20	0.20	0.09	0.03
8. Tokua, soybean curd	72.74	1.15	46.94	1.97	0.53	3.97	0.16	0.04
9. Toyo, soybean sauce bought from Kwong Me Chan	63.43	23.32	1.36	0.86	0.31	2.68	1.70	0.62
10. Toyo, soybean sauce bought from Sengkee and Co., trade name "Sol"	63.36	21.58	0.75	0.43	0.16	0.56	0.32	0.12
11. Toyo, soybean sauce bought at Azcarraga 1601, Manila, trade name, "Great Eastern"	62.15	23.66	0.56	0.35	0.13	0.35	0.21	0.08
12. Toyo, soybean sauce, trade name, "Violin", bought from Philippine Products Manufacturing Company	61.61	23.68	0.96	0.59	0.22	1.15	0.70	0.27
13. Toyo, soybean sauce, trade name, "Rooster," bought from Kwong Shing Yuen	60.74	19.33	0.13	0.06	0.02	0.65	0.31	0.12
Crustacean products								
1. Bagoong alamang, Cavite, salted and fermented small shrimps (*Penaeus* spp.)	67.76	14.71	0.42	0.20	0.06	0.45	0.21	0.06
2. Bagoong alamang, Zamboanga, salted and fermented small shrimps (*Penaeus* spp.)	59.91	20.60	2.95	0.15	0.60	3.15	1.61	0.64
3. Heko, the solid residue from patis manufacture (See No. 6)	65.72	9.06	0.50	0.13	0.04	2.23	0.59	0.20
4. Hibe, shrimps (*Penaeus* spp.), dried and with skin removed	23.07	12.99	8.69	1.47	1.12	3.59	0.61	0.46
5. Hipon, maalat, salted and dried shrimps (*Palaemon* spp.)	37.69	20.67	10.00	3.31	2.06	15.84	5.25	3.27
6. Patis alamang, Cavite, sauce obtained by boiling salted and fermented small shrimps (*Penaeus* spp.)	67.52	24.59	0.11	0.08	0.02	0.11	0.83	0.02
Egg products								
1. Balut, duck egg incubated 18 days; then boiled:								
a. Chick (embryo duckling)	91.37	1.22	26.69	3.37	0.32	16.68	2.35	0.20
b. Liquid	97.63	0.49	11.96	2.47	0.05	5.78	1.19	0.02
c. White (albumen)	64.48	0.69	22.69	0.44	0.15	11.37	0.22	0.07
d. Yolk	52.87	1.54	55.55	1.81	0.85	11.02	0.35	0.16
Average	76.59	0.99			0.34			0.11
2. Maalat, boiled salted duck egg	67.92	3.45	13.88	0.14	0.47	1.74	0.18	0.06
3. Malasado, soft-boiled fresh chicken egg	74.03	0.91	26.64	0.80	0.24	5.21	0.15	0.04
4. Penoy, hard-boiled fresh duck egg	70.80	1.00	12.88	0.44	0.12	3.76	0.12	0.03
Fish products								
1. Bagoong dilis, Cavite, salted and fermented anchovies (*anchovia* spp.)	68.73	16.66	1.64	0.87	0.27	1.16	0.61	0.19
2. Bagoong dilis, Iloco, salted and fermented anchovies (*anchovia* spp.)	62.77	24.53	3.28	2.16	0.80	0.39	0.25	0.09
3. Bagoong itlog ng bangos, salted and fermented eggs of milkfish (*chanos chanos* Farkadal)	87.15	2.41	42.73	8.01	1.02	2.21	0.41	0.05
4. Daing ayunging, dry-salted grunt, (*Pristopoma hasta*, Block)	26.56	26.76	20.73	7.55	5.54	23.15	8.43	6.19
5. Daing bacalao, dry-salted codfish (*Gadus* sp.)	26.43	18.42	9.72	2.43	1.79	4.26	1.06	0.78
6. Daing dalag, dry-salted mudfish, (*Ophicephalus striatus* Block)	30.65	16.50	13.15	3.12	2.16	8.90	2.11	1.46
7. Daing Kanduli, dry-salted catfish, (*Arius* sp.)	25.51	18.82	9.56	2.44	1.79	2.28	0.58	0.42
8. Dilis, dried anchovies (*anchovia* sp.)	24.80	30.82	19.09	7.82	5.88	13.04	5.34	4.01
9. Tinapa, tunsoy, salted and smoked herring, (*Narengula* sp.)	48.18	6.01	13.91	1.61	0.83	5.08	0.58	0.30
Fruit products								
1. Buro balimbi, salted and preserved balimbi, (*Averrohoa carambola* Linn.) —(solid portions)	85.82	5.35	0.55	0.20	0.03	1.07	0.40	0.05
2. Buro camias, salted and preserved camias, (*Averrohoa bilimbi* Linn.)—(solid portion)	94.44	2.28	1.74	0.71	0.04	0.89	0.36	0.02
3. Buro manga, salted and preserved sliced green mango, (*Mangifera indica* Linn.)—(solid portion)	82.60	3.31	1.55	0.29	0.05	0.97	0.18	0.03
4. Buro manga, salted and preserved whole green mango, (*Mangifera indica* Linn.)—solid portion)	83.87	3.81	1.22	0.28	0.04	0.56	0.13	0.02
Meat products								
1. Satsaron, pork cracklings	2.81	0.99	10.78	0.2;	0.10	3.24	0.06	0.03
Vegetable products								
1. Buro labanos, salted and preserved radish, (*Raphanus sativus* Linn.)	94.36	2.42	1.51	0.64	0.03	2.85	1.22	0.06
2. Buro mustasa, salted and preserved mustard (*Brassica juncea* F.-Vi 11)	91.12	3.80	12.36	5.31	0.04	1.39	0.59	0.005

[a] All dialect names used in this table are Tagalog.

METHODS OF COMPUTING THE NUMBER OF DAYS COVERED BY AN EVENT IN PERIODS OF TWO MONTHS OR OVER[1]

LEOPOLDO B. UICHANCO
Of the Department of Entomology

While working up the data obtained in breeding experiments on insects of which the life histories extended through periods of several months, the writer faced the necessity of resorting to quicker and less tiresome methods of computation than the ones ordinarily used. On account of the irregularity in numbers of days in the different calendar months, the usual method of finding with the help of a calendar the total in the entire and fractional months for every period considered is tediously slow and, on account of the varied steps required for each operation, lends itself to frequent errors. With the aid of a table, such as the one herein presented, the task is greatly lightened. Moreover, it has the advantage over the older method in that the processes involved in each operation can be performed practically automatically.

These methods are, of course, very elementary, and undoubtedly not only other biological investigators, but also statisticians must be using similar drudgery-saving aids. So far as the writer knows, however, no one has taken the trouble to publish in a readily accessible form a description of such methods, at least for the benefit of beginners in experimental work.

Table for calculating days covered by varying numbers of calendar months

	TO JAN. 31	TO FEB. 28	TO MARCH 31	TO APRIL 30	TO MAY 31	TO JUNE 30	TO JULY 31	TO AUG. 31	TO SEPT. 30	TO OCT. 31	TO NOV. 30	TO DEC. 31
From												
January 1	**396**	59	90	120	151	181	212	243	273	304	334	365
February 1	**365**	**393**	59	89	120	150	181	212	242	273	303	334
March 1	**337**	**365**	**396**	61	92	122	153	184	214	245	275	306
April 1	**306**	**334**	**365**	**395**	61	91	122	153	183	214	244	275
May 1	**276**	**304**	**335**	**365**	**396**	61	92	123	153	184	214	245
June 1	**245**	**273**	**304**	**334**	**365**	**395**	61	92	122	153	183	214
July 1	**215**	**243**	**274**	**304**	**335**	**365**	**396**	62	92	123	153	184
August 1	**184**	**212**	**243**	**273**	**304**	**334**	**365**	**396**	61	92	122	153
September 1	**153**	**181**	**212**	**242**	**273**	**303**	**334**	**365**	**395**	61	91	122
October 1	**123**	**151**	**182**	**212**	**243**	**273**	**304**	**335**	**365**	**396**	61	92
November 1	**92**	**120**	**151**	**181**	**212**	**242**	**273**	**304**	**334**	**365**	**395**	61
December 1	**62**	**90**	**121**	**151**	**182**	**212**	**243**	**274**	**304**	**335**	**365**	**396**

Explanations. Figures in bold-face type represent the number of days from dates indicated to those in year following; in ordinary type, in the same year. An allowance of one day in February should be made for leap years.

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[1] Experiment Station contribution No. 720. Received for publication December 15, 1930.

Methods of using table. 1. If the period includes a maximum of thirteen whole months and if it begins on or after the first day of a given month and ends before the last day of a later month: (*a*) Find in the table the number of days from the first of the month in initial date of the period to be computed to the end of the month preceding that in closing date. (*b*) Subtract the number of days in the initial date from the number of days in the closing date. (*c*) Add (*a*) and (*b*). (*See* Examples 1 and 2.)

2. If the period includes a maximum of thirteen whole months and if it begins on the first day of a given month and ends on the last day of a later month: Find in the table the number of days corresponding to the months covered, and deduct 1 day. (*See* Example 3.)

3. If the period includes fourteen whole months, or over, and the month in the initial date precedes in calendar sequence that in closing date: (*A*) Subtract the initial from the closing year and multiply the difference by 365 days. In case one, or more, of the years preceding the closing date is a leap year add 1 day to the product for each leap year that includes a part or the entire month of February. One day is allowed for a leap year in the closing date only when the day given is February 29 or when the month follows February in calendar sequence. (*B*) Proceed as in method 1 or 2, and add the result to (*A*). (*See* Examples 4, 5, and 6.)

4. If the period includes fourteen whole months, or over, and the month in the initial date follows in calendar sequence that in closing date: Proceed as in method 3; but in (A) deduct 1 year from the difference between the closing and the initial years. (*See* Example 7.)

Example 1. To find duration in number of days from May 17, 1929, to October 13, 1929:

(*a*) May 1 to September 30 (see table) =153 days
(*b*) 13 days (October)–17 days (May) =–4 days
(*a*) + (b) = 153–4 =149 days. *Ans.*

Example 2. To find duration in number of days from September 3, 1929, to October 28, 1930:

(*a*) September 1, 1929, to September 30, 1930=395 days
(*b*) 28 days (November)–3 days (September) =25 days
(*a*) + (b) =395 + 25 =420 days. *Ans.*

Example 3. To find duration in number of days from February 1, 1929, to November 30, 1929:

February 1 to November 30=303 days
Less 1 day =302 days. *Ans.*

Example 4. To find duration in number of days from February 15, 1928, to May 7, 1930:

(*A*) 1930-1928=2 years
(2×365) + 1=731 days

Note.—One day is added above because 1928, which is a leap year, begins in February.

(*B*) (*a*) February 1, 1930, to April 30, 1930 =89 days
(*b*) 7 days (May, 1930)–15 (February, 1928) =–8 days
(*a*) + (*b*) =89–8 =81 days
(*A*) + (*B*) =731+81 =812 days. *Ans.*

Example 5. To find duration in number of days from March 16, 1908, to May 12, 1920.

(*A*) 1920-1908 = 12 years
(12×365)+3 = 4,383 days

Note.—Three days are added above because of the leap years 1912, 1916, and 1920; the last, which is the closing year, ends after February. No allowance is made for 1908, which is the initial year, because it begins after February.

(*B*) (*a*) March 1, 1920, to April 30, 1920 = 61 days
(*b*) 12 days (May, 1920)–16 days (March, 1908) =–4 days
(*a*) + (*b*) =61–4 =57 days
(*A*) + (*B*) =4,383+57 =4,440 days. *Ans.*

Example 6. To find duration in number of days from March 1, 1928, to November 30, 1930:

(*A*) 1930-1928 = 2 years
2×365 = 730 days
(*B*) March 1, 1930, to November 30, 1930, less 1 day =274 days
(*A*) + (*B*) =730+274 = 1,004 days. *Ans.*

Example 7. To find duration in number of days from August 26, 1926, to February 7, 1930:

(*A*) (1930–1926) –1 = 3 years
(3 × 365) + 1 = 1,096 days
(*B*) (*a*) August 1, 1929, to January 31, 1930 = 184 days
(*b*) 7 days (February, 1930)–26 days (August, 1926) =–19 days
(*a*) + (*b*) =184–19 =165 days
(*A*) + (*B*) = 1,096+165 = 1,261 days. *Ans.*

COLLOID CONTENT OF MILL JUICES UNDER NORMAL MACERATION AND LESS MACERATION[1]

MANUEL R. MONSALUD

WITH FIVE CHARTS AND ONE TEXT FIGURE

Zsigmondy (1865) states that the contents and membranes of cells consist of colloids and that the sap of plants is intrinsically a colloidal solution. The juice of the sugar cane is more or less a colloidal solution with water as the dispersion medium. According to Zerban (1920), these colloids in the extracted cane juice are chiefly proteids, polyphenol compounds and related coloring matters, clay, fiber, and coarse dispersoids, and large particles of soil and fiber. Besides these there probably are formed adsorption complexes which further complicate the situation. It is obvious, therefore, that in the course of milling or grinding the cane one deals with substances primarily colloidal in nature.

These colloids in the cane juice are obstacles in obtaining efficient and rapid clarification. The greater their quantity in a mixed juice, the greater the difficulty, as a rule, encountered in the defecation[2] of the juice. These colloids, unless totally or largely eliminated by defecation, later affect adversely boiling house operations as graining and crystallization. Bond (1924) says that colloids are the source of many difficulties in filtration and of viscous low grades and that inboiling tends to retard crystallization and increases viscosity owing probably to colloid behavior.

In the normal juice of the cane, there is a certain amount of colloids actually present. Hence it is important to trace the points where these colloids are extracted from the cane or the bagasse in a greater or less bulk while the milling is going on so that there will be an index as to whether or not the primary juice should be separated from the secondary juice[3] or corresponding defecations, as the amounts of colloids present in both primary and secondary juices differ too greatly to warrant their separate clarifications. It is also of practical value to determine whether the application of more maceration water is advantageous or not. The addition of more maceration water effects higher sucrose extraction, as a rule, but it may also introduce more colloids into the juice thus rendering clarification more difficult.

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[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Sugar Technology from the College of Agriculture No. 393; Experiment Station contribution No. 721. Prepared in the laboratory of Pampanga Sugar Development Co., San Fernando, Pampanga, under the direction of Prof. R. H. King of the Department of Agricultural Chemistry, College of Agriculture.

[2] According to Noel Deerr (1921), by defecation is meant the process by means of which a clear negotiable juice is obtained by the combined action of heat, lime, settling, and decantation.

[3] The primary juice is the juice extracted when there is no maceration water applied—crusher and first mill juices.

The secondary juice is the juice extracted when there is maceration water applied. In this case the second mill, third mill, and the fourth mill juices constitute the secondary juice.

REVIEW OF PAST LITERATURE

No work has been published in the Philippines on the determination of colloid content of mill juices under normal and under less maceration. In Hawaii, however, Bond (1924) found that the colloids in the mill juices increased steadily from mill to mill, reaching a maximum at the last mill. This condition he found to be true under dry crushing and with maceration. The method of analysis he used to determine the colloids was not the "dye test", the method used in the present investigation, but by filtration through a cotton filter about one inch thick. He termed colloids those suspensions that did not settle after one hour at rest. This is not strictly true but it served as a means for comparison and satisfactory rapid working.

Paine and Balch (1928), using the dye test, showed that the dye value[4] of mill juices increased from the crusher to the third mill, but dropped in the fourth mill.

Paine, Keane, and McCalip (1928) worked on the effect of phosphate content on colloidal elimination during defecation. They concluded that colloid elimination is unquestionably greater at the higher pH values and that the greater the phosphate content of cane juice, the greater the colloid elimination. This, they explained, is due primarily to the adsorption and bringing down of colloids by the precipitated calcium phosphate.

Copp (1930) states that the amount of colloids that are introduced into the juice depends largely upon the efficiency of milling and imbibition or maceration. "The higher this efficiency, the larger the amount of colloids in the macerated juice and the greater the need of efficient clarification."

OBJECT OF THE PRESENT WORK

The main object of the work reported in this paper was to determine the relative colloid content of mill juices under normal and under less maceration.

The secondary aims were: (*a*) To determine the relative apparent purities of the mill juices under normal and under less maceration; (*b*) to find the percentage of colloid elimination in the clarified juice.

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[4] Badollet and Paine (1926) defined the dye value or dye number as an isoelectric ratio, that is, the ratio of the weight (in mgm.) of dye to the weight (in mgm.) of solids; the colloid content of which is electrically neutralized by the dye.

TIME AND PLACE

The work was carried out in the laboratory of the Pampanga Sugar Development Company, under the direction of Prof. R. H. King of the Department of Agricultural chemistry, College of Agriculture, and with the permission and assistance of Mr. Wenceslao Trinidad, the manager, and Mr. Tranquilino Ventura, the Chief Chemist. The analyses were all made at night (from 6:00 p. m. to 6:00 a. m.). The analyses were performed in December, 1929 and in January, 1930.

JUICES ANALYZED UNDER NORMAL MACERATION AND LESS MACERATION

In the present investigation the following mill juices were analyzed under normal and under less maceration:

- *a.* Crusher juice
- *b.* 1st mill juice
- *c.* 2nd mill juice
- *d.* 3rd mill juice
- *e.* 4th mill juice
- *f.* Mixed juice

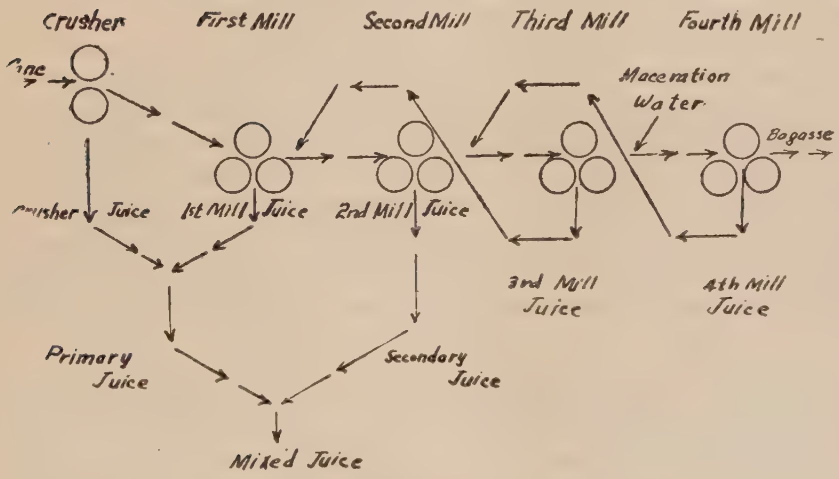
Crusher
First Mill
Second Mill
Third Mill
Fourth Mill
Cane
Maceration Water
Bagasse
Crusher Juice
1st Mill Juice
2nd Mill Juice
3rd Mill Juice
4th Mill Juice
Primary Juice
Secondary Juice
Mixed Juice

Fig. 1

Fig. 1.—Shows a diagrammatic sketch of Mill Tandem A at the Pampanga Sugar Development Co. showing the sources of the different mill juices analyzed in this study.

METHODS

Corrected Brix determination

The sampling was divided into three types. For the first half of the time spent in this study, only samples for the *normal running* were taken, that is, while the sampling was being done no attempt was made to alter the amount of maceration water applied. Six sampling cans of about

700 cc. capacity each were used. A canful of juice was taken from the crusher, from the 1st mill, 2nd mill, 3rd mill, 4th mill, and mixed juice of mill tandem in the order named until the six sampling cans were filled. The filled cans were taken to the laboratory for analysis.

During the second half of the time spent in this study, samples under normal maceration and under less maceration were taken. The procedure of sampling was as follows: Twelve sampling cans were used. Six were for normal maceration and the other six for less maceration. From the tandem of the mill a canful of juice was taken from the crusher, 1st mill, 2nd mill, 3rd mill, 4th mill, and from the mixed juice, in the order named, one after the other. No attempt was made to alter the amount of maceration water applied while the sampling was going on. Immediately after taking these six samples for the normal maceration, samples were taken in a like manner for the less maceration tests. In the second case, however, the amount of maceration water applied was reduced[5] by shutting off, partly, the flow of maceration water. In this way comparable samples were obtained for the normal and for the less maceration determinations.

In this work, the treatment by the milling plant on the juices obtained for the *normal running* and *normal maceration* was the same, that is, both could be termed normal running or normal maceration because no attempt was made in either case to reduce or increase the amount of maceration water while the sampling was going on. The term "normal maceration" was used in the second case to differentiate it from "less maceration". The samples in both cases (normal and less maceration) were taken one after the other, whereas, after taking samples for normal running, no samples were taken for less maceration. In other words, during the first half of this investigation analyses were made only on samples for normal running. During the second half, analyses were made on samples for normal maceration and for less maceration for comparison, the samples being taken simultaneously.

The methods of analyses of the juice samples in the laboratory were the same for all samples in the three cases; namely, normal running, normal maceration, and less maceration.

The corrected Brix determination was performed in accordance with the method given in *Methods of Chemical Control for Cane Sugar Factories* (Anonymous) (1924). The juice from each sampling can was poured through a copper strainer into a glass cylinder. This was done to remove the coarse, suspended "cush-cush", or particles of bagasse. The filled cylinder containing the strained juice was placed in a water trough up to the neck for about fifteen minutes so as to cool the juice to room temperature and to allow the air bubbles to escape. Then the Brix spindle, which was wiped dry, was carefully inserted into the juice; this made the juice overflow the cylinder and the foam on top could be blown off. When the spindle became steady its stem was read at the level of the lower meniscus of the juice. Three readings were made and averaged for the uncorrected Brix. Then the temperature of the juice was taken. The Brix determinations were corrected to 27.5°C.

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[5] At first an attempt was made to take samples for dry crushing tests instead of less maceration only, but during dry crushing sampling or the shutting off entirely of maceration water, the mills choked before the sampling was over. Besides the central would incur a much heavier loss in sucrose as the entire shutting off of maceration water for even five minutes would reduce sucrose extraction considerably.

Apparent purity determination

After recording the corrected Brix, the juice from each glass cylinder was poured into a 600 cc. pyrex beaker and stirred well. About 100 cc. of juice from each 600 cc. pyrex beaker were poured into a 500 cc. pyrex beaker and to this were added about 2 grams of Horne's dry lead-subacetate reagent and the mixture was stirred thoroughly with a stirring rod, filtered, and polarized. Using the polariscopic reading and the uncorrected Brix, polarization was found in table 4 of *Methods of Chemical Control for Cane Sugar Factories.*

To find the apparent purity of the juice, its polarization was multiplied by 100 and the product divided by the corrected Brix.

Dye value determination

The colloid content of mill juices was determined by means of the dye test. The following description of this method is quoted from Spencer and Meade (1929), who abstracted it from articles by Badollet and Paine (1926).

> The flocculation of colloids may be accomplished by the addition of free ions with an electric charge the opposite of that of the colloidal particles, or by adding a quantity of oppositely charged colloid sufficient to produce mutual electric neutralization. In general the colloidal particles in sugar products are negatively charged. When a negatively charged colloid is mixed with a positively charged colloid in a certain proportion, a point of electrical neutrality is reached at which the charges exactly neutralize each other, frequently causing mutual colloidal flocculation, and producing a precipitate that settles out of solution. If at this so called "iso-electric point" the liquid containing the suspended flocs is examined with an ultramicroscope fitted with a cataphoresis apparatus, no movement of the colloidal particles or aggregates toward either electrode is observed. (Cataphoresis is the migration or progression of colloidal particles in a solution under the influence of an electric current.)
>
> The cataphoresis apparatus[6] consists of a U-tube, the center portion of which is capillary, and which has a platinum electrode in each arm. The apparatus is fastened rigidly under the microscope, through which the motion of colloidal particles in the capillary is observed. When the colloidal solution has been mixed with a portion of the solution containing the oppositely charged colloid, it is poured into the cataphoresis cell, and an electric potential is impressed on the electrodes. If the colloids present in the solution are not at a point of electrical equilibrium, they will progress toward the positive electrode if their charge is negative, and toward the negative electrode if their charge is positive. If they are at the "iso-electric point", the point where the electrical charges are exactly neutralized, they will show no progression toward either electrode.

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[6] See figure 44 of Spencer and Meade (1929) for the picture of the apparatus.

The electric charges of the colloids in sugar liquor may be neutralized by any of several dyes, night blue being the one used most extensively, owing to the fact that it produces the most rapid flocculation and a precipitate that settles most rapidly. In making the test 1 gram of the solid dye is dissolved in distilled water, and made up to the mark in a liter flask. The solution to be tested should be first adjusted to some pH value[7].

The "dye number" or dye value is calculated as follows: The weight of solids used in the test is determined either by weighing beforehand, as in the case of raw and washed sugars, or by measurement and the use of the specific gravity or the refractive index. Then the number of milliliters of dye solution necessary for neutralization of the colloids in the sugar solution, multiplied by 100 and divided by the weight of dry solids used in the test, will be the "dye number" of the substance in question.

Paine and Balch (1928) gave the following formulas for the computation of the dye value. The solids content of the sample is the basis for calculating the dye value.

First case— Where a definite volume of sample is taken;

$$\text{Dye value} = \frac{\text{wt. of dye required} \times 100{,}000}{\text{vol. of sample} \times \text{sp. gr.} \times {}^{\circ}\text{Brix}}$$

Second case—Where a definite weight of sample is taken;

$$\text{Dye value} = \frac{\text{wt. of dye required} \times 100{,}000}{\text{wt. of sample} \times {}^{\circ}\text{Brix}}$$

The method used in determining the dye value of the mill juices in this work was the same as the one described above, with slight modification.

The mill juices tested were strained though a 100-mesh screen. At first, 5 cc. of the juice sample were pipetted into a clean 250 cc. pyrex beaker and diluted with 100 cc. of distilled water and stirred vigorously.

A certain volume of the night blue solution was added, the mixture stirred and observed under the ultramicroscope. If the colloid particles migrated to the positive electrode, it showed that they were still negatively charged, in which case the stopcock was opened and the solution drained into the former container. More night blue solution was added, stirred well, and the mixture was again observed in the cataphoresis cell. This process was repeated until the colloid particles failed to migrate toward either anode or cathode when an electric current was turned on. This marked the isoelectric point of the neutralization or of the test. The volume of dye used, expressed in cc., was recorded and used, together with the volume, specific gravity, and degree Brix of the mill juice analyzed, in the calculation for the dye value as shown in Paine and Balch's formula, first case.

RESULTS

The data actually determined were the uncorrected Brix, temperature in °C., polarization reading, volume of juice samples used for each dye test, volume of dye required in each dye test, specific gravity of the mill juices by the use of their corrected Brix and by reference to table 1 in *Methods of Chemical Control for Cane Sugar Factories.*

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[7] In the present study, the pH values of the different mill juices did not differ enough to produce appreciable errors, so for practical reasons and for simplicity, there was no need of pH value standardization.

The data calculated from these determined data and shown in tables 1 and 2 are the corrected Brix, apparent purity, and dye value for normal running, normal maceration, and less maceration.

Data in table 3 are arranged so as to facilitate comparison of corrected Brix under normal and under less maceration of the mill juices.

Table 4 shows average dye value of mill juices under normal maceration together with maceration per cent cane for the whole 24-hour period. This average dye value is found by averaging the dye values of the tests in table 2 that have the same maceration per cent cane, or those which were made on the same day.

Data calculated from other data

Table 2 shows the average daily analyses of the mixed and clarified juices. (These data were obtained from the laboratory records of Pasudeco, (the abbreviated name of the Pampanga Sugar Development Company) with the permission of the chief chemist, Mr. T. Ventura.)

The method of analysis used by the laboratory assistant in analyzing for the corrected Brix, apparent purity, and dye value of the mixed and clarified juices was the same as the one employed in this study. Having determined the dye values of the mixed juice and the corresponding clarified juice, percentage of colloid elimination by lime defecation is calculated as follows:

$$\begin{array}{l}\text{Percentage of colloid elimi-}\\ \text{nation by lime defecation}\end{array} = \frac{d \text{ of M. J.} - d \text{ of C. J.} \times 100}{d \text{ of M. J.}}$$

where d_v stands for dye value; *M.J.* for the mixed juice; *C. J.* for the clarified juice.

The other data obtained by calculation from the laboratory record book for daily analysis or factory control were fiber per cent cane, fiber per cent bagasse, maceration per cent normal juice, dilution per cent, hours grinding, tons cane ground, and tons cane ground per hour. All of these data are shown in tables 1 and 2.

Table 6 shows the relationship between the quotient of corrected Brix under normal maceration divided by the corrected Brix under less maceration and the quotient of the cubic centimeters of dye used up by one cubic centimeter of the fourth mill juice under normal maceration divided by the cubic centimeters of dye used up by one cubic centimeter of the fourth mill juice under less maceration.

Table 7 shows the variations, that is, the minimum, maximum, and average corrected Brix, apparent purity, and dye value of the mill juices under normal running, normal maceration and less maceration.

For the computation of the juice extraction per cent cane and the juice extraction per cent juice in cane under conditions obtaining in Pasudeco, *see* Gomez (1931).

DISCUSSION OF RESULTS

The data in tables 1 and 2 as graphically shown in chart 1 show that there was a gradual drop in the corrected Brix from mill to mill in the three cases; namely, normal running, normal maceration, and less maceration. The corrected Brix as a rule, was highest in the crusher and lowest in the 4th mill. The corrected Brix of the mixed juice was between these two extremes. This would be expected as the mixed juice is a mixture of the five mill juices. The drop in the corrected Brix between the 3rd mill and 4th mill was more marked in normal running and normal maceration, which were about the same, than that under less maceration. This drop was due to effect of dilution. The more water that is added, the less the corrected Brix.

The results indicate that the apparent purity decreased from mill to mill. It was also highest in the crusher and lowest in the 4th mill. That of the mixed juice came somewhere between these two extremes.

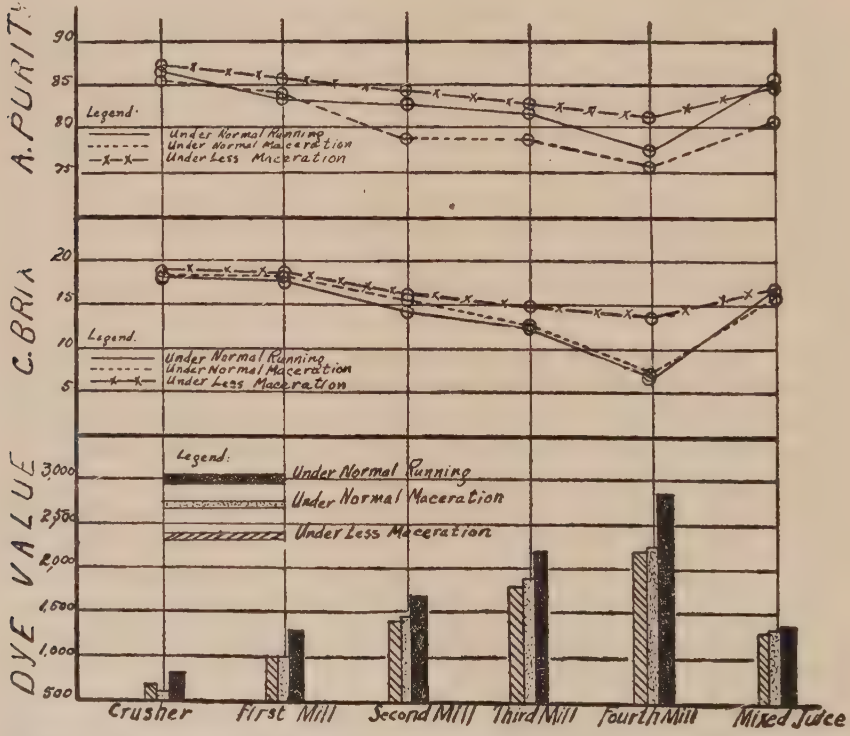

Chart 1. Shows comparative average apparent purity, corrected Brix, and dye value of mill juices under normal running, normal maceration, and less maceration.

Deerr (1921) attributes the steady decrease in apparent purity from mill to mill wholly to the differences in purity between rind and pith juices. Deerr had determined by analyses that the pith juice is richer in sucrose than the rind juice, and that the former is largely extracted by the first set of mills, whereas, the latter is extracted by the last mills. Bond (1924) expressed a doubt as to the veracity of the whole of Deerr's statement. Bond claimed that it is difficult to understand how the purity of last mill juice can be accounted for by rind juice alone. "If this were strictly true," he said, "dry crushing tests should demonstrate the point quite as well as maceration tests." Bond further said that juices are primarily molecularly dispersed systems, independent of the colloidal nature of fiber. "It is reasonable to suppose that the impurities of last mill juices are from rind fiber for the most part since it comprises about 75 per cent of cane fiber. Apparently, the purity is dependent upon the treatment of the fiber in the milling process. Dilution effects cannot contribute toward the low purity of mill juices now in normal practice as the deterioration of juices." However, the addition of maceration water may dissolve some impurities in the bagasse and the introduction of these impurities in the juice lowers its purity.

With reference to the dye value, there was a gradual increase from mill to mill in the three cases. In all the mills, the dye values under normal running were greater than those under normal maceration and less maceration. This was due to the differences in the quality of the cane. Under normal and under less maceration the dye values were close to each other. It is interesting to note that in the crusher juice and in the 1st mill juice, the dye values under less maceration were slightly higher than those under normal maceration, but as the canes traveled from the 2nd to the 4th mill where they were affected by maceration, the dye values were greater under normal maceration than under less maceration. Copp (1930) attributes this difference to the fact that the amount of colloids introduced into the juice depends to a great extent upon the efficiency of milling and maceration. The higher this efficiency, the greater is the amount of colloids in the macerated juice, hence the need for better clarification. Bond (1924) noted that maceration milling actually did increase to a considerable extent the impurities in the juice. Inasmuch as cane fiber is colloidal in nature, it is reasonable to expect that impurities, if they are added from the fiber, will be colloidal to some extent. As a result of mechanical action alone on the fiber in the presence of a desirable medium like water or diluted juice, together with the breaking down of cell walls followed by flushing with water, colloids are introduced in the mill juices, for this gives a very good means for the extraction of protoplasmic matter and other colloidal material confined normally within the cell wall. (Colloids may be prepared from cane fiber by continued grinding of prepared bagacillo in the presence of water.) During milling it is obvious that particles of fiber of all degrees of subdivision are formed.

Table 3 shows the corrected Brix of the mill juices under normal and under less maceration. Samples were taken simultaneously in the two cases. This table facilitates comparison. With the exception of the crusher and 1st mill juices, the corrected Brix of the other mill juices are higher in less maceration than in normal maceration owing to dilution.

Table 4 shows average dye value of mill juices with normal maceration together with maceration per cent cane. From this table it cannot be seen whether dye value is a function of maceration per cent cane or not. The maceration per cent cane was taken as the average for the twenty-four, hour period. Had the maceration per cent cane at that particular instant, when the samples were being taken, been known, it might be possible to come to a definite conclusion as to whether the dye values of the 2nd, 3rd, and 4th mill juices, the juices having the effects of maceration, were functions of the maceration per cent cane or not. For obvious reasons it was not possible, however, to determine the maceration per cent cane at the instant the samples were taken in this study.

Table 5 shows the average daily analysis of the mixed and clarified juices. (From the Pampanga Sugar Development Co. laboratory data.) The table shows that the percentage of colloid elimination ranged from 9.98 to 32.24 with an average of 15.55.

There was no attempt in this work to explain the variation in colloid elimination by simple lime defecation. Paine, Keane, and McAlip (1928), give the following summary or results from their exhaustive study on the *Influence of Phosphate and Colloid Contents of Cane Juices on Defecation.*

a. P_2O_5 content of raw juice showed a linear relation to colloid elimination as determined by the dye test.

b. Increase colloid elimination at higher P_2O_5 content was accompanied by an increase in the weight and volume of mud.

c. With increasing P_2O_5 content of raw juice the rate of increase in volume was greater than the rate of increase in weight in mud.

d. Increasing the pH to which the juice was limed increased the colloid elimination and also materially increased the content of lime salts in defecated juice.

e. The content of lime salts per 100° Brix showed a definite relation to the content of reversible colloids in defecated juice.

f. Excess of lime in defecation apparently has peptizing effect on the gummy substances in the juice, as there is an increase in quantity of reversible colloids proportionate to the increase in lime salts, a portion of which is of colloidal character.

g. It is believed that lime compounds are more detrimental in raw cane sugar manufacture than is generally recognized, as they adversely affect boiling house operations.

h. Adding P_2O_5 to a juice deficient in phosphates increases colloid elimination as determined by ultrafiltration.

i. A distinct reduction in lime compounds per 100° Brix was noted in juices, which had been defecated after addition of phosphate.

> Colloid elimination by dye test was distinctly greater in double defecation, which method also gave a larger rise in apparent purity as well as a slightly better general appearance. This is attributable, in a measure at least, to colloid elimination by acid defecation of the lower purity juices, where the quantity of mud is proportionately large.

Table 6 shows the relation between

$$\frac{\text{C. Brix normal maceration}}{\text{C. Brix less maceration}} \text{ and } \frac{\text{cc. dye normal maceration}}{\text{cc. dye less maceration}}$$

in the 4th mill. The data in table 6 show that, as a rule, the greater the amount of gravity solids or Brix on the 4th mill juice the greater the amount of night blue solution needed to neutralize the colloids present in the juice.

Table 7 shows the minimum, maximum, and average (variations) corrected Brix, apparent purity, and dye value of the mill juices under normal running, normal maceration, and less maceration.

SUMMARY AND CONCLUSIONS

1. An investigation involving 156 determinations on the colloid content, as determined by the dye test or by the use of ultramicroscope-cataphoresis apparatus, of mill juices of a Philippine sugar central was conducted.

2. The dye values of the charged colloids of the mill juices appear to be a function of the quality of cane ground.

3. The dye value of the crusher juice averaged 674 for the period, while variation ranges from 331 to 1191.

4. Tests conducted with more and less maceration indicate that maceration water has effect upon the colloidal content of the last mill juices. Within a certain limit, the more maceration water applied, the more colloid content in the 2nd, 3rd, and 4th mill juices.

5. The corrected Brix and apparent purity steadily decreased from mill to mill, was highest as a rule, in the crusher and lowest in the 4th mill. On the other hand, the dye value increased from mill to mill, was lowest in the crusher and highest in the 4th mill juice.

6. The amount or bulk of colloids of the juice from each mill appears to be related to the amount of juice extracted by each mill.

7. The data obtained indicate that the colloids are present in the juice and are expressed with the juice. Furthermore, the mechanical action of the mills in the presence of maceration water or dilute juice tends to introduce more colloids in the juice from the bagasse.

8. Dye value determinations on the mixed juice and clarified juice at pH 7.5-7.8 indicate an average of 15.55 percentage removal of colloids by the usual lime defecation used in the Pampanga Sugar Development Co. for the period of this study. The variation in the percentage of colloid elimination ranges from 9.98 to 32.24 for the period.

9. Between normal maceration and less maceration millings, the amount of dye needed to neutralize the charged colloids in the 4th mill juice appears to be a linear function of the corrected Brix, that is, the greater the corrected Brix in the 4th mill juice, the greater the amount of night blue dye required to neutralize the charged colloids in that juice.

10. To a certain extent, the addition of maceration water produces more colloids in the juice, but this disadvantage is not alarming and is upset by the higher sucrose extraction brought about by efficient maceration.

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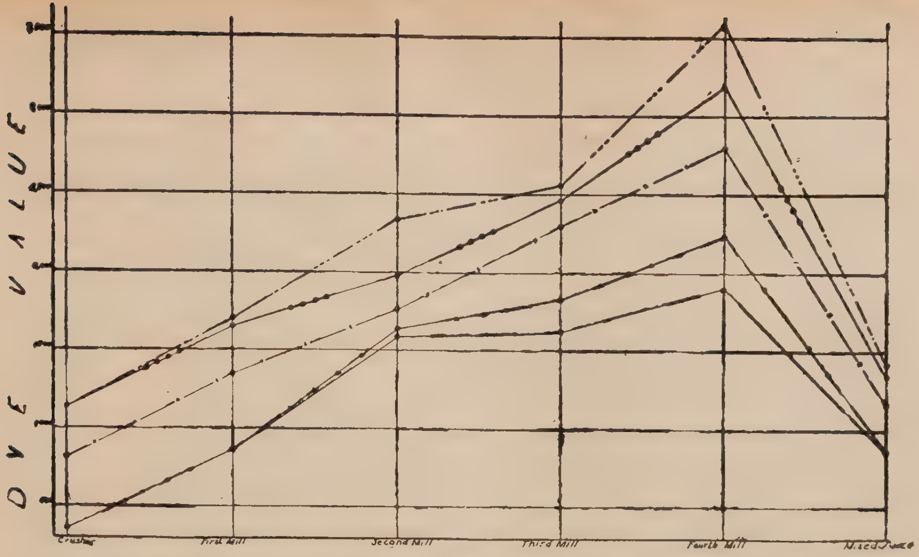

Chart 2.—Showing maximum, average and minimum dye values of the mill juices under normal running independent of the run: maximum and minimum crusher juice dye values and the dye values of the other mill juices through a single run under normal running.

Legend: Under normal running and independent of the run
— -.- — --- — maximum dye values of the mill juices
—x—x— average dye values of the mill juices
———————— minimum dye values of the mill juices
Under normal running and through a single run
—ooo—ooo— maximum crusher juice dye values and the dye values of the other mill juices
—vvvv—vv— minimum crusher juice dye value and the dye values of the other mill juices

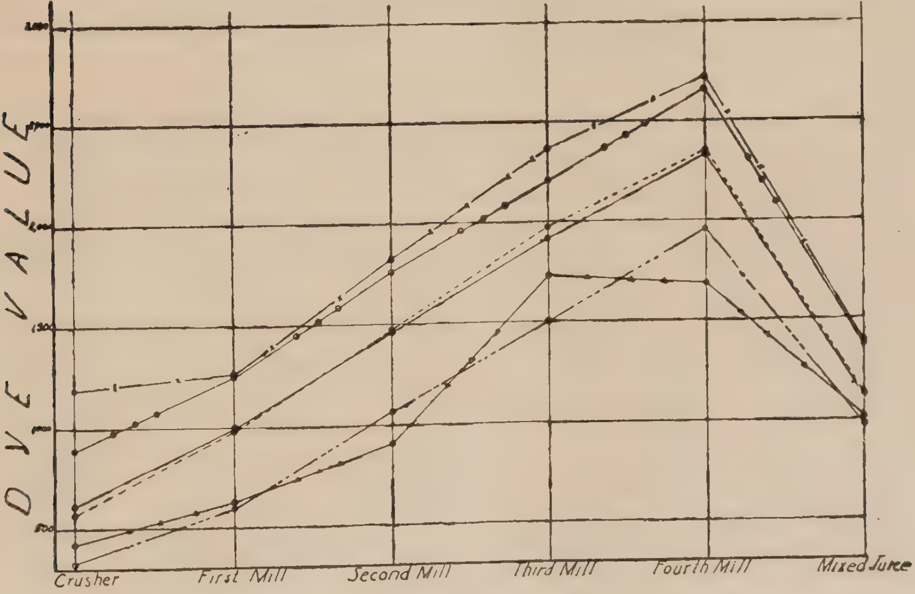

Chart 3.—Showing maximum, average, and minimum dye values of the mill juices under normal maceration and less maceration independent of the run.

Legend: Normal maceration and independent of the run
—ooo—ooo— maximum dye values of the mill juices
— — — — — — average dye values of the mill juices
—vvv—vvv— minimum dye values of the mill juices
Less maceration and independent of the run
—x—x— Maximum dye values of the mill juices
———————— average dye values of the mill juices
— ---·— --- — minimum dye values of the mill juices

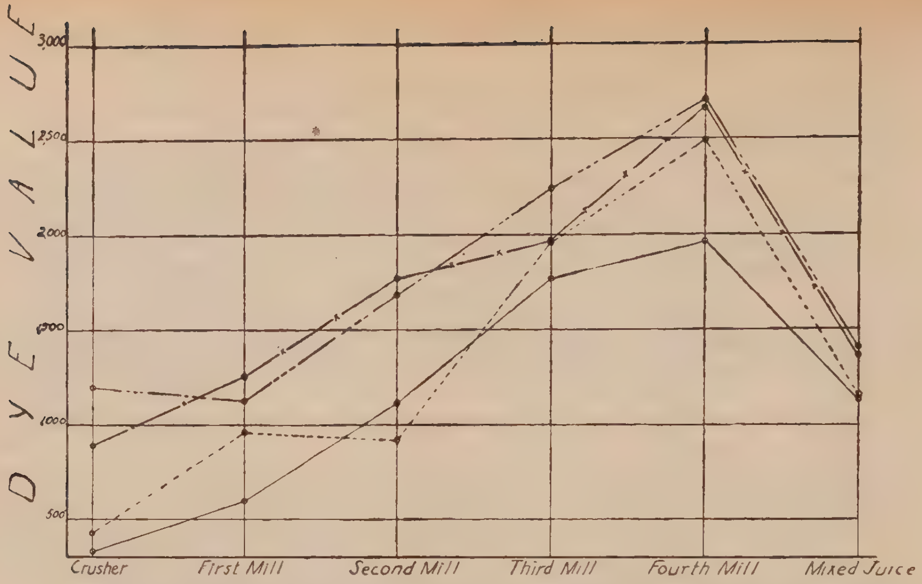

Chart 4.—Showing maximum and minimum crusher juice dye values together with the dye values of the other mill juices through a single run under normal maceration and less maceration.

Legend: Normal maceration through a single run

——x——x——x—maximum crusher juice dye value together with the dye values of the other mill juices

— — — — — — minimum crusher juice dye value together with the dye values of the other mill juices

Less maceration through a single run

— - - - — - - - — maximum crusher juice dye value together with the dye values of the other mill juices

—————————— minimum crusher juice dye value together with the dye values of the other mill juices

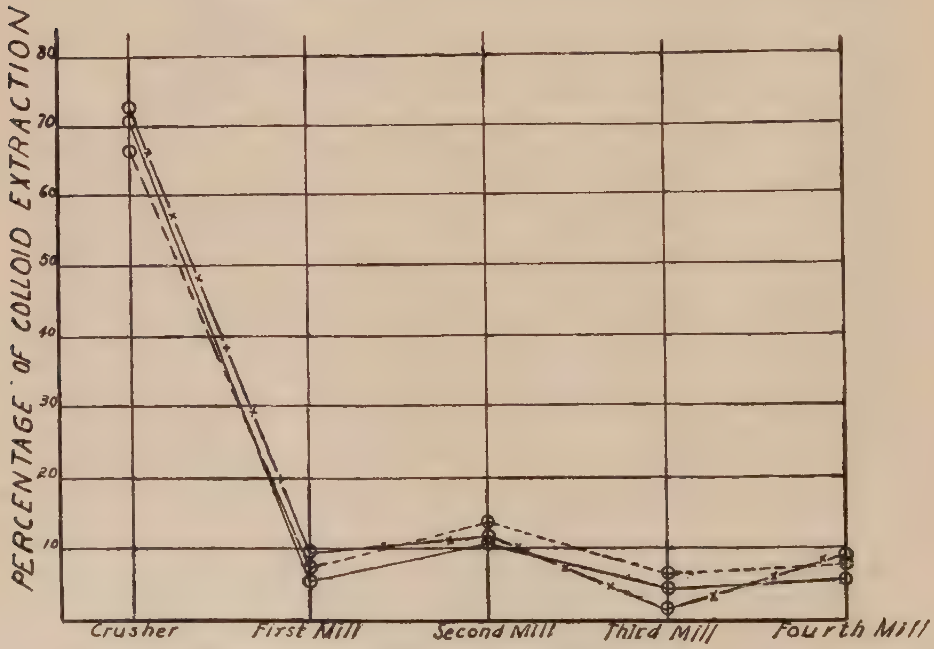

Chart 5.—Showing percentage of colloid extraction by mills.

Legend:

—————————— under normal running

— — — — — — under normal maceration

——x——x——x— under less maceration

TABLE 1

Showing corrected Brix, apparent purity and dye value of mill juices under normal running

SAMPLE NUMBER		CRUSHER JUICE			1ST MILL JUICE			2ND MILL JUICE			3RD MILL JUICE		
		C. Brix	A. purity	D. value	C. Brix	A. purity	D. value	C. Brix	A. purity	D. value	C. Brix	A. purity	D. value
12/10/30, Tuesday.....	1	19.36	90.28	935	19.04	89.33	1376	14.71	86.53	1952	10.61	83.12	2480
12/11/30, Wednesday...	2	18.44	89.53	758	18.44	87.25	1143	14.31	85.88	1652	12.48	85.09	2224
Wednesday...	3	19.24	90.74	1062	19.30	88.49	1248	14.81	86.42	1797	12.61	84.77	2190
12/12/30, Thursday....	4	18.59	92.20	999	18.70	89.35	1506	14.61	87.13	1927	12.74	86.81	2262
Thursday....	5	20.39	98.81	741	19.66	86.72	1241	17.51	84.69	1706	13.88	82.99	2002
Thursday....	6	17.89	89.04	676	17.54	87.28	1386	14.01	83.79	1960	10.81	83.81	2502
12/13/30, Friday.......	7	19.10	89.05	972	19.41	87.06	1384	18.11	85.75	1594	15.58	84.21	2049
Friday.......	8	18.52	84.71	1104	18.09	82.86	1542	15.36	80.14	2334	14.34	77.75	2392
Friday.......	9	15.68	86.03	1139	15.92	84.10	1654	15.16	82.65	1982	13.20	82.72	2460
12/14/30, Saturday.....	10	19.80	92.57	1073	19.84	88.55	1540	16.35	80.85	2000	13.26	83.55	2420
Saturday.....	11	17.52	86.24	1012	17.64	85.43	1695	14.67	83.08	1926	11.76	79.93	2428
12/17/30, Tuesday.....	12	18.66	86.65	838	18.64	84.28	1550	14.79	83.23	1929	12.21	81.65	2891
Tuesday.....	13	20.29	75.70	818	19.96	73.39	1481	15.30	74.64	1790	12.61	73.19	2500
Tuesday.....	14	17.78	86.50	785	17.79	88.19	1309	14.96	86.23	1635	12.31	84.89	2403
Tuesday.....	15	19.91	69.31	744	19.46	68.70	1333	16.45	67.22	1704	13.68	67.39	2222
12/18/30, Wednesday...	16	19.10	89.42	825	19.15	89.34	1353	15.21	89.67	1734	12.51	84.87	2137
Wednesday...	17	17.52	82.36	665	17.60	76.19	1436	14.35	79.09	1842	11.78	77.84	2602
Wednesday...	18	17.95	87.40	690	17.80	86.79	1354	13.86	82.61	1986	11.72	81.22	2439
12/19/30, Thursday....	19	18.80	90.85	829	18.57	88.90	1350	14.73	86.76	1923	11.55	85.45	2231
Thursday....	20	18.27	86.53	561	18.24	84.86	1225	12.28	82.89	1783	11.18	81.75	1624
Thursday....	21	18.36	87.27	558	18.60	86.01	1128	10.58	83.11	1651	10.55	81.80	2455
Thursday....	22	21.86	87.28	798	21.80	87.06	1177	16.38	87.54	2171	12.58	86.24	2045
12/21/30, Saturday.....	23	18.06	88.75	670	18.07	86.82	1134	13.84	85.76	1781	12.05	84.64	2222
Saturday.....	24	19.09	89.62	829	18.76	88.11	1337	15.43	86.34	1699	11.45	85.06	2250
Saturday.....	25	18.88	71.23	784	19.10	70.41	1359	15.20	70.79	1301	12.72	68.39	2388
12/22/30, Sunday......	26	17.86	88.01	781	18.44	86.11	1263	14.81	84.87	1720	11.88	84.76	2339
12/25/30, Monday.....	27	18.64	76.82	697	19.14	74.29	1359	15.28	76.37	1852	12.18	77.17	2558
Monday.....	28	18.79	85.36	347	18.65	84.87	846	13.40	81.34	1631	11.01	79.56	1826
Average.		18.73	86.01	810	18.68	84.64	1347	14.83	82.70	1761	12.83	81.44	2305

SAMPLE NUMBER		4TH MILL JUICE			MIXED JUICE			FIBER PER CENT CANE	FIBER PER CENT BAG-ASSE	MACE-RATION PER CENT N. J.	DILU-TION PER CENT	HOURS GRIND-ING	TONS CANE GROUND	TONS CANE PER HOURS
		C. Brix	A. purity	D. value	C. Brix	A. purity	D. value							
12/10/30, Tuesday.....	1	6.01	76.37	3120	17.34	88.98	1414	10.60	46.62	11.94	7.47	23.55	1810.13	76.863
12/11/30, Wednesday...	2	6.81	75.77	3036	16.54	87.60	1155	10.65	46.91	13.09	8.65	22.50	1731.20	76.942
Wednesday...	3	6.35	79.05	2926	17.60	88.92	1378	10.65	46.91	13.08	8.65	22.50	1731.20	76.942
12/12/30, Thursday....	4	7.28	82.14	3196	16.90	93.72	1206	10.74	45.88	11.18	6.12	21.33	1676.52	78.599
Thursday....	5	8.18	80.19	2858	17.96	83.58	880	10.74	45.88	11.18	6.12	21.33	1676.52	78.599
Thursday....	6	6.28	77.58	3098	16.79	88.20	1225	10.74	45.88	11.18	6.12	21.33	1676.52	78.599
12/13/30, Friday.......	7	11.08	83.12	2502	18.26	85.65	1280	10.80	46.42	9.07	4.04	22.67	1818.00	80.061
Friday.......	8	7.64	47.73	3576	17.90	88.71	1249	10.80	46.42	9.07	4.04	22.67	1815.00	80.061
Friday.......	9	8.54	79.85	3187	15.62	84.89	1338	10.80	46.42	9.07	4.04	22.67	1815.00	80.061
12/14/30, Saturday.....	10	6.61	78.97	2569	17.87	88.47	1197	10.48	45.85	8.84	4.06	23.50	899.56	38.279
Saturday.....	11	5.72	76.92	2916	16.40	85.49	1428	10.48	45.85	8.84	4.06	23.50	899.56	38.279
12/17/30, Tueasday....	12	6.21	76.32	2981	16.90	84.55	1326	10.60	46.63	9.10	4.38	23.33	1973.65	84.597
Tuesday.....	13	6.48	69.14	2707	17.75	74.82	1263	10.60	46.63	9.10	4.38	23.33	1973.55	84.597
Tuesday.....	14	7.21	81.55	2699	16.36	87.83	1046	10.60	46.63	9.10	4.38	23.33	1973.65	84.597
Tuesday.....	15	6.61	68.53	2507	16.40	81.83	1086	10.60	46.63	9.10	4.38	23.33	1973.65	84.597
12/18/30, Wednesday...	16	6.45	80.46	2719	17.66	88.90	1111	11.00	45.36	9.75	4.97	23.42	1958.44	83.622
Wednesday...	17	6.38	72.72	2905	17.06	77.08	1093	11.00	45.36	9.75	4.97	23.42	1958.44	83.622
Wednesday...	18	6.26	77.31	2960	16.06	86.23	1228	11.00	45.36	9.75	4.97	23.42	1958.44	83.622
12/19/30, Thursday....	19	6.80	80.58	2528	17.05	89.20	1044	11.10	45.28	13.50	9.39	23.42	1796.00	76.686
Thursday....	20	6.05	74.21	2581	15.14	82.76	932	11.10	45.28	13.50	9.39	23.42	1796.00	76.686
Thursday....	21	5.97	76.88	2619	16.34	84.02	1034	11.10	45.28	13.50	9.39	23.42	1796.00	76.686
Thursday....	22	6.89	81.85	2260	19.80	89.04	935	11.10	45.28	13.50	9.39	23.42	1796.00	76.686
12/21/30, Saturday.....	23	7.22	81.02	2692	16.30	87.54	1034	10.81	46.55	10.86	6.55	20.83	1655.58	79.408
Saturday.....	24	6.75	79.11	2586	16.52	86.28	1124	10.81	46.55	10.86	6.55	20.83	1655.58	79.480
Saturday.....	25	6.98	63.75	2789	17.51	79.89	1117	10.58	46.55	10.86	6.55	20.83	1655.58	79.480
12/22/30, Sunday......	27	6.33	73.12	2928	17.07	86.44	1154	10.70	47.37	12.96	7.52	22.25	1740.94	77.345
12/23/30, Monday.....	27	7.29	73.12	1910	17.27	74.81	1243	10.70	47.37	12.96	9.10	22.50	1553.00	69.020
Monday.....	28	6.56	75.30	2239	16.46	83.11	852	10.70	47.37	12.96	9.10	22.50	1553.00	69.020
Average.		6.87	77.03	2789	17.03	85.31	1156	10.73	46.31	11.09	6.57	——	——	74.681

TABLE 2

Comparing corrected Brix, apparent purity and dye value of the mill juices under normal and less maceration
(Sampling done simultaneously)

SAMPLE NUMBER		CRUSHER JUICE						1ST MILL JUICE					
		C. Brix		A. purity		D. value		C. Brix		A. purity		D. value	
		Normal	Less	Normal	Less	Normal	Less	Normal	Less	Normal	Less	Normal	Less
12/28/29, Saturday....	1	18.13	16.62	86.54	82.49	564	1017	18.03	16.60	84.02	81.08	1031	1133
12/29/29, Sunday	2	18.34	17.86	88.71	88.52	558	417	18.29	17.84	86.27	86.32	1066	1047
Sunday......	3	17.45	17.58	89.39	88.22	428	529	17.55	17.88	88.88	86.29	957	938
12/30/29, Monday.....	4	16.79	19.11	86.53	84.03	615	680	17.09	19.04	91.04	83.77	984	1073
Monday.....	5	18.22	18.32	88.25	87.44	561	812	18.48	18.20	83.82	86.37	1055	1276
1/ 3/30, Friday......	6	18.76	19.46	89.49	77.64	891	1191	18.52	19.78	86.87	75.42	1256	1121
Friday......	7	18.60	18.74	85.10	89.16	650	792	18.28	18.72	83.64	88.46	1066	990
1/ 5/30, Sunday......	8	19.05	17.14	89.92	85.64	683	820	19.32	17.52	86.69	84.36	1148	1223
Sunday......	9	18.98	18.75	79.92	81.54	585	792	19.29	19.12	77.81	78.81	962	1214
Sunday......	10	17.95	20.28	78.10	90.68	570	545	21.62	21.35	88.76	91.33	636	601
1/ 6/30, Monday.....	11	21.42	22.16	89.16	89.71	472	331	21.66	21.66	88.68	89.79	636	593
Monday.....	12	19.41	19.25	79.23	82.85	571	625	19.61	19.99	77.20	80.29	1085	1019
Monday.....	13	17.82	20.15	78.78	91.11	576	550	21.52	21.32	89.41	91.60	641	603
1/ 7/30, Tuesday.....	14	21.97	21.49	91.48	89.29	458	513	21.80	21.20	88.85	88.39	1051	1169
Tuesday.....	15	19.32	19.42	72.36	73.73	670	714	19.59	19.45	70.30	70.95	1085	1238
Tuesday.....	16	21.32	22.12	81.21	82.92	472	331	18.35	18.76	83.43	83.55	1066	935
1/ 8/30, Wednesday..	17	17.96	17.83	90.64	89.19	674	838	18.29	18.02	89.45	89.12	1015	1088
Wednesday..	18	18.19	17.89	88.12	86.92	513	677	18.34	17.98	86.15	86.20	1060	1088
Wednesday..	19	21.45	22.19	88.43	89.27	513	372	21.16	21.55	89.79	91.04	696	596
1/ 9/30, Thursday....	20	19.55	18.05	87.92	84.12	569	464	19.58	18.36	86.31	84.91	1038	909
Thursday....	21	19.59	18.43	86.93	84.04	567	505	19.69	18.12	86.08	84.87	1079	974
Thursday....	22	17.92	20.15	78.23	91.27	573	550	18.22	18.85	83.97	88.33	1122	905
1/10/30, Friday......	23	17.88	20.36	80.82	91.06	573	543	18.12	19.96	77.87	89.08	1026	1168
Friday......	24	17.86	20.18	78.78	91.38	573	548	18.52	20.19	77.59	88.21	1055	1096
Friday......	25	21.42	22.15	88.70	88.89	515	331	17.95	18.82	84.12	88.20	1088	985
Average.		19.01	19.43	84.59	86.45	576	620	19.16	19.21	84.68	85.47	996	999

SAMPLE NUMBER		2ND MILL JUICE						3RD MILL JUICE					
		C. Brix		A. purity		D. value		C. Brix		A. purity		D. value	
		Normal	Less	Normal	Less	Normal	Less	Normal	Less	Normal	Less	Normal	Less
12/28/29, Saturday....	1	15.03	16.54	76.97	80.65	1509	1469	13.16	16.27	76.82	77.13	2086	1525
12/28/29, Sunday......	2	15.32	16.51	81.92	85.40	1472	1420	12.76	16.46	80.56	84.75	2015	1818
Sunday......	3	15.16	16.30	84.89	86.01	920	1437	12.63	16.72	84.16	85.65	1955	1732
12/30/29, Monday.....	4	15.00	16.92	81.93	82.66	1447	1492	11.93	17.16	81.06	82.46	2080	1784
Monday.....	5	16.09	16.54	82.03	85.85	1656	1752	12.90	16.25	80.70	83.47	1765	2254
1/ 3/30, Friday......	6	15.99	18.56	81.30	75.96	1765	1684	13.59	16.63	78.52	79.00	1958	2247
Friday......	7	15.26	16.83	82.56	86.80	1420	1500	13.02	16.74	81.95	86.26	1898	1732
1/ 5/30, Sunday......	8	14.13	13.96	82.23	82.30	1544	1554	12.16	12.50	81.17	80.80	1811	2061
Sunday......	9	18.04	16.00	76.33	78.81	1392	1647	14.54	14.52	75.58	80.03	1961	2013
Sunday......	10	15.02	17.19	76.10	87.26	1572	1413	13.20	16.28	76.36	77.09	2087	1552
1/ 6/30, Monday.....	11	18.42	18.44	85.55	87.14	1566	1111	14.93	15.46	83.59	84.22	1835	1779
Monday.....	12	16.36	16.36	73.71	77.93	1376	1829	13.52	12.86	71.82	77.22	1818	2370
Monday.....	13	14.99	16.61	77.32	80.61	1509	1469	12.66	16.71	83.73	85.58	1925	1732
1/ 2/30, Tuesday.....	14	17.76	18.75	84.90	85.39	1571	1386	14.04	13.14	82.98	81.35	1929	2013
Tuesday.....	15	14.96	18.28	69.11	77.03	1509	1523	13.66	13.86	69.47	76.12	1736	2192
Tuesday.....	16	15.19	17.29	75.91	87.28	1553	1351	13.26	16.30	76.24	77.18	2071	1552
1/ 8/30, Wednesday..	17	16.20	14.91	85.37	87.32	1561	1582	11.60	11.90	85.26	84.62	2051	2240
Wednesday..	18	15.72	15.24	81.61	84.31	1377	1069	12.90	12.46	84.84	82.82	2132	2290
Wednesday..	19	15.02	16.64	77.36	80.89	1509	1348	12.90	16.80	80.01	85.65	1985	1667
1/ 9/30, Thursday....	20	16.33	15.75	81.56	82.67	1552	1488	13.36	12.48	81.21	82.69	1844	2137
Thursday....	21	15.79	14.66	81.19	88.54	1429	1548	12.90	12.76	81.01	81.58	1985	2288
Thursday....	22	15.66	17.30	73.75	87.45	1497	1351	13.03	16.18	74.44	78.76	1898	1512
1/10/30, Friday......	23	15.03	17.20	76.05	87.03	1572	1413	12.16	13.22	75.82	84.19	2288	2014
Friday......	24	15.02	17.50	76.76	86.34	1572	1431	12.06	13.61	74.38	82.29	2205	1944
Friday......	25	15.36	17.00	75.33	89.05	1534	1374	12.90	16.21	82.40	80.51	1985	1502
Average.		15.71	16.70	79.27	84.02	1495	1466	13.03	14.94	79.20	81.66	1971	1916

TABLE 2—(Continued)

Comparing corrected Brix, apparent purity and dye value of the mill juices under normal and less maceration
(Sampling done simultaneously)

SAMPLE NUMBER		4TH MILL JUICE						MIXED JUICE					
		C. Brix		A. purity		D. value		C. Brix		A. purity		D. value	
		Normal	Less	Normal	Less	Normal	Less	Normal	Less	Normal	Less	Normal	Less
12/28/29, Saturday. . . .	1	6.92	16.02	73.41	78.40	1690	2222	16.75	16.34	82.39	86.41	1061	1207
12/29/29, Sunday.	2	6.57	16.12	78.23	81.70	2537	2384	16.56	16.50	84.66	85.76	1186	1136
Sunday.	3	6.67	16.80	77.06	83.47	2500	2056	16.19	16.89	86.78	89.22	1156	1105
12/30/29, Monday.	4	6.18	17.56	73.46	80.53	2308	2143	16.32	17.76	83.09	83.84	1149	1099
Monday.	5	7.01	16.32	77.31	84.32	2222	2471	17.19	16.76	83.31	84.25	1033	1325
1/ 3/30, Friday.	6	7.66	17.55	80.81	74.30	2658	2698	16.39	17.34	85.21	79.58	1371	1398
Friday.	7	6.72	13.16	77.68	85.26	2609	2086	15.57	16.16	82.85	17.02	1084	1073
1/ 5/30, Sunday.	8	6.87	13.78	73.94	80.04	1972	2069	16.06	16.38	85.06	83.82	1111	1086
Sunday.	9	7.75	8.23	73.29	73.88	2625	2688	17.76	17.84	79.11	79.55	1099	1152
Sunday.	10	6.60	16.18	78.64	81.58	2500	2370	19.52	19.80	84.22	89.04	1043	1028
1/ 6/30, Monday.	11	7.70	16.22	80.12	82.68	2405	1965	19.53	19.76	86.39	89.11	1137	1121
Monday.	12	7.06	11.33	70.54	74.93	2192	2735	17.65	17.19	76.54	82.83	1058	1196
Monday.	13	6.76	16.25	78.55	81.48	2464	2370	19.09	19.36	86.07	90.96	1068	1053
1/ 7/30, Tuesday.	14	7.65	14.90	80.00	81.14	2405	2468	17.81	19.90	84.44	89.60	1099	972
Tuesday.	15	9.34	10.17	66.06	72.07	2062	2453	17.12	18.86	68.75	74.50	1093	1034
Tuesday.	16	6.18	17.54	73.62	80.73	2381	2074	16.63	17.32	70.78	84.30	1180	1027
1/ 8/30, Wednesday. .	17	6.88	9.91	81.25	84.16	2055	2621	16.12	16.15	83.81	92.63	1337	1221
Wednesday. .	18	7.00	10.31	77.72	81.77	2500	2710	17.52	16.49	84.47	86.11	1011	1023
Wednesday. .	19	6.28	17.60	73.41	80.17	2500	2011	16.39	17.10	71.20	84.68	1143	1038
1/ 9/30, Thursday. . . .	20	8.28	12.13	79.34	80.79	2003	2283	17.12	16.53	83.76	86.81	1148	1136
Thursday. . . .	21	7.84	13.05	76.15	83.91	2469	2253	17.49	17.63	82.97	77.70	1016	1058
Thirsday. . . .	22	6.70	16.29	77.46	80.23	2464	2299	19.06	19.66	85.52	87.59	1165	1227
1/10/30, Friday.	23	7.78	11.15	69.67	82.60	2625	2414	16.62	17.40	70.82	83.79	1186	1022
Friday.	24	9.54	11.05	68.55	81.72	2222	2435	16.79	17.52	69.98	82.08	1173	1047
Friday.	25	7.18	16.61	76.46	84.29	2466	2260	17.00	18.86	71.94	92.36	1154	1133
Average.		7.25	14.25	75.71	80.65	2353	2338	17.21	17.65	80.57	85.02	1131	1113

SAMPLE NUMBER		FIBER PER CENT CANE	FIBER PER CENT BAGASSE	MACERATION PER CENT CANE	DILUTION PER CENT N. J.	TONS CANE GROUND	HOURS GRINDING	TONS CANE PER HOUR
12/28/29, Saturday. . . .	1	10.60	47.91	11.55	7.52	1905.92	23.50	81.10
12/29/29, Sunday.	2	10.74	47.40	11.10	7.41	1755.08	22.25	78.88
Sunday.	3	10.74	47.40	11.10	7.41	1755.08	22.25	78.88
12/30/29, Monday.	4	10.76	47.25	14.24	10.60	1036.92	13.25	78.25
Monday.	5	10.76	47.25	14.24	10.60	1036.92	13.25	78.25
1/ 3/30, Friday.	6	10.60	47.24	10.52	6.51	1943.83	23.50	82.71
Friday.	7	10.60	47.24	10.52	6.51	1943.83	23.50	82.71
1/ 5/30, Sunday.	8	10.71	47.51	11.91	7.91	1656.81	21.34	77.64
Sunday.	9	10.71	47.51	11.91	7.91	1656.81	21.34	77.64
Sunday.	10	10.71	47.51	11.91	7.91	1656.81	21.34	77.64
1/ 6/30, Monday.	11	11.03	47.55	10.95	6.51	1188.51	15.00	79.24
Monday.	12	11.03	47.55	10.95	6.51	1188.51	15.00	79.24
Monday.	13	11.03	47.55	10.95	6.51	1188.51	15.00	79.24
1/ 7/30, Tuesday.	14	10.73	47.52	13.88	7.13	1839.68	22.75	80.87
Tuesday.	15	10.73	47.52	13.88	7.13	1839.68	22.75	80.87
Tuesday.	16	10.73	47.52	13.88	7.13	1839.68	22.75	80.87
1/ 8/30, Wednesday. .	17	10.86	46.95	11.53	7.43	1897.10	22.67	83.68
Wednesday. .	18	10.86	46.95	11.53	7.43	1897.10	22.67	83.68
Wednesday. .	19	10.86	46.95	11.53	7.43	1897.10	22.67	83.68
1/ 9/30, Thursday. . . .	20	10.84	47.25	11.11	7.06	2044.17	24.00	85.17
Thursday. . . .	21	10.84	47.25	11.11	7.06	2044.17	24.00	85.17
Thursday. . . .	22	10.84	47.25	11.11	7.06	2044.17	24.00	85.17
1/10/30, Friday.	23	10.83	46.81	11.20	7.22	1868.83	22.58	82.76
Friday.	24	10.85	46.81	11.20	7.22	1868.83	22.58	82.76
Friday.	25	10.83	46.81	11.20	7.22	1868.83	22.58	82.76
Average. .		10.77	47.34	11.80	7.53	———	———	81.03

TABLE 3

Showing corrected Brix of the mill juices under normal and less maceration. (Sampling done simultaneously)

TEST NUMBER	LESS MACERATION						NORMAL MACERATION					
	Cr.	1st	2nd	3rd	4th	M. J.	Cr.	1st	2nd	3rd	4th	M. J.
1	16.62	16.60	16.54	16.27	16.02	16.34	18.13	18.03	15.03	13.16	6.92	16.75
2	17.86	17.84	16.51	16.46	16.12	16.50	18.34	18.29	15.32	12.76	6.57	16.56
3	17.58	17.88	16.30	16.72	16.80	16.89	17.45	17.55	15.16	12.63	6.67	16.19
4	19.11	19.04	16.92	17.16	17.56	17.76	16.79	16.09	15.00	11.93	6.18	16.32
5	18.32	18.20	16.54	16.25	16.32	16.76	18.22	18.48	16.09	12.90	7.01	17.19
6	19.46	19.78	18.56	16.63	17.25	17.34	18.76	18.52	15.99	13.59	7.66	16.39
7	18.74	18.72	16.83	16.74	13.16	16.16	18.60	18.28	15.26	13.02	6.72	15.57
8	17.14	17.52	13.96	12.50	13.78	16.38	19.05	19.32	14.13	12.16	6.87	16.06
9	18.75	19.12	16.00	15.52	8.23	17.84	18.98	19.29	18.04	14.54	7.75	17.76
10	20.28	21.30	17.19	16.28	16.18	19.80	17.95	21.62	15.02	13.20	6.60	19.52
11	22.16	21.66	18.44	15.46	16.22	19.76	21.42	21.66	18.42	14.93	7.70	19.53
12	19.25	19.99	16.36	12.86	11.33	17.19	19.41	19.61	16.36	13.52	7.06	17.65
13	20.15	21.32	16.61	16.71	16.25	19.36	17.82	21.52	14.99	12.66	6.76	19.09
14	21.49	21.20	18.75	13.14	14.90	19.90	21.97	21.80	17.76	14.04	7.65	17.81
15	19.42	19.45	18.28	13.86	10.17	18.86	19.32	19.59	14.96	13.66	9.34	17.12
16	22.12	18.76	17.29	16.30	17.54	17.32	21.32	18.35	15.19	13.26	6.18	16.63
17	17.83	18.02	14.91	11.90	9.91	16.15	19.96	18.29	16.20	11.60	6.88	16.12
18	17.89	17.98	15.24	12.46	10.31	16.49	18.19	18.34	15.72	12.90	7.00	17.52
19	22.19	21.25	16.64	16.80	71.60	17.10	21.45	21.16	15.02	12.90	6.28	16.39
20	18.05	18.36	15.75	12.48	12.13	16.53	19.55	19.58	16.33	13.36	8.28	17.12
21	18.45	18.12	14.66	12.76	13.05	17.63	19.59	19.69	15.79	12.90	7.84	17.49
22	20.15	18.85	17.30	16.18	16.29	19.66	17.92	18.22	15.66	13.03	6.70	19.06
23	20.36	19.96	17.20	13.22	11.15	17.40	17.88	18.12	15.03	12.16	7.78	16.62
24	20.18	20.19	17.50	13.61	11.05	17.52	17.86	18.52	52.02	12.06	9.54	16.72
25	22.15	18.82	17.00	16.21	16.61	18.86	21.42	17.95	15.36	12.90	7.18	17.00
Average....	19.43	19.12	16.70	14.94	14.25	17.66	19.01	19.16	15.71	13.03	7.25	17.21

TABLE 4

Showing average dye value of mill juices with normal maceration together with maceration per cent cane

TEST NUMBER	AVERAGE DYE VALUE OF MILL JUICES						MACERATION PER CENT CANE
	Crusher	1st	2nd	3rd	4th	Mixed juice	
1	493	1012	1194	1985	2519	1171	11.10
2	588	1020	1552	1923	2265	1091	14.24
3	771	1161	1593	1928	2634	1228	10.52
4	613	915	1503	1953	2366	1084	11.91
5	540	787	1484	1869	2354	1088	10.95
6	533	1067	1544	1922	2283	1124	13.88
7	567	924	1482	2056	3252	1164	11.53
8	570	1080	1493	1909	2312	1110	11.11
9	554	1056	1559	2126	2438	1171	11.20
10	935	1376	1952	2480	3120	1414	11.94
11	910	1196	1725	2207	2981	1267	13.09
12	805	1344	1864	2255	3051	1104	11.18
13	1072	1527	1970	2300	3088	1289	9.07
14	1043	1618	1963	2424	2788	1313	8.84
15	796	1418	1765	2504	2724	1180	9.10
16	727	1381	1854	2393	2861	1144	9.75
17	687	1220	1882	2089	2497	986	13.50
18	761	1277	1760	2287	2689	1092	10.86
19	781	1263	1720	2339	2928	1154	11.73
20	522	1103	1742	2192	2075	1048	12.96

TABLE 5

Showing average daily analysis of the mixed and clarified juices. (From Pasudeco laboratory data)

TEST NUMBER	BRIX		A. PURITY		D. VALUE		PER CENT COLLOIDS ELIMINATED BY DEFECATION
	M. J.	C. J.	M. J.	C. J.	M. J.	C. J.	
1	16.2	16.3	86.3	87.7	1252	1026	11.05
2	16.1	16.3	85.8	86.6	1003	1126	13.58
3	16.4	16.8	85.7	86.7	1303	1093	16.17
4	16.8	17.1	84.2	84.7	1444	1200	16.90
5	16.8	17.3	84.3	86.2	1290	1134	12.09
6	17.2	17.4	85.5	86.8	1201	1072	10.74
7	16.5	16.8	83.0	81.7	1297	1093	15.73
8	16.8	16.9	85.1	86.5	1252	1127	9.98
9	16.8	16.8	85.2	86.6	1274	1124	11.77
10	16.9	17.2	83.5	24.8	1219	1076	11.73
11	16.8	17.1	84.4	86.1	1147	938	18.22
12	16.8	16.8	84.3	85.6	1333	1180	11.48
13	16.6	17.1	83.5	84.9	1274	1098	13.81
14	16.8	17.3	83.7	84.8	1226	1018	16.97
15	16.3	15.4	87.4	84.1	1231	1100	10.64
16	16.1	16.4	87.4	87.6	1401	1207	13.85
17	16.3	15.8	85.7	87.7	1316	1106	15.96
18	16.9	17.7	81.1	84.2	1550	1269	18.13
19	16.5	16.3	84.6	86.4	1224	1209	15.10
20	16.9	16.7	95.9	86.4	1431	1222	14.61
21	16.7	17.5	83.6	85.2	1226	979	20.15
22	16.5	17.1	82.4	85.7	1299	1086	16.40
23	16.7	16.6	84.8	85.3	1323	1106	16.63
24	16.6	17.1	85.2	85.8	1422	941	32.24
25	16.8	17.1	85.5	86.9	1176	942	19.90

TABLE 6

Showing the relation between $\dfrac{\textit{C. Brix normal maceration}}{\textit{C. Brix less maceration}}$

and $\dfrac{\textit{cc. dye normal maceration in the 4th mill}}{\textit{cc. dye less maceration}}$

SAMPLE NUMBER	$\frac{\text{C. BRIX NORMAL MACERATION}}{\text{C. BRIX LESS MACERATION}}$	$\frac{\text{CC. DYE NORMAL MACERATION}}{\text{CC. DYE LESS MACERATION}}$
1	6.92+16.02=0.432	1.2+3.8=0.316
2	6.57+16.12=0.408	1.7+4.1=0.415
3	6.67+16.80=0.397	1.7+3.7=0.460
4	6.18+17.56=0.352	1.5+3.9=0.385
5	7.01+16.32=0.430	1.6+4.3=0.372
6	7.66+17.55=0.436	2.1+5.1=0.412
7	6.72+13.16=;.511	1.8+2.9=0.621
8	6.87+17.18=0.400	1.4+3.0=0.467
9	7.75+ 8.23=0.942	2.1+2.2=0.955
10	6.60+16.18=0.408	1.7+4.1=0.415
11	7.70+16.22=0.475	1.9+3.4=0.559
12	7.06+11.33=0.623	1.6+3.2=0.500
13	6.76+16.25=0.416	1.7+4.1=0.415
14	7.65+14.90=0.513	1.9+3.9=0.487
15	9.34+10.17=0.918	2.0+2.6=0.769
16	6.18+17.54=0.352	1.5+3.9=0.385
17	6.88+ 9.91=0.694	1.5+2.7=0.556
18	7.00+10.31=0.679	1.8+2.9=0.621
19	8.28+17.60=p.357	1.6+3.8=0.421
20	8.28+12.13=0.683	1.9+2.9=0.655
21	7.84+13.05=0.601	2.6+3.1=0.839
22	6.70+16.29=0.411	1.7+4.0=0.425
23	7.78+11.15=0.689	2.1+2.8=0.750
24	9.54+11.05=0.863	2.2+2.8=0.786
25	7.18+16.61=0.432	1.8+4.0=0.450
Average..	0.537	0.537

TABLE 7

Showing the minimum, maximum, and average corrected Brix, apparent purity and dye value of the mill juices under normal running, normal maceration, and less maceration

		NORMAL RUNNING			NORMAL MACERATION			LESS MACERATION		
		Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Crusher juice	C. Brix	15.68	21.86	18.73	16.79	21.97	19.01	16.62	22.19	19.43
	A. purity	69.31	92.57	86.01	72.36	91.48	84.59	73.73	91.38	86.45
	Dye value	347	1139	810	428	891	576	331	1191	620
1st mill juice	C. Brix	15.92	21.80	18.68	17.09	21.80	19.16	16.60	21.66	19.21
	A. purity	68.70	89.35	84.64	70.30	91.04	84.68	70.95	91.60	85.47
	Dye value	865	1695	1347	641	1256	996	593	1276	999
2nd mill juice	C. Brix	10.58	18.11	41.83	14.13	18.42	15.71	13.76	18.75	16.70
	A. purity	67.22	89.67	82.70	69.11	85.55	79.27	75.96	89.06	79.27
	Dye value	1594	2334	1761	820	1765	1495	1069	1829	1466
3rd mill juice	C. Brix	10.55	15.58	12.83	11.60	14.93	13.03	11.90	17.16	14.94
	A. purity	67.39	86.81	81.44	69.47	85.26	79.20	76.12	86.26	81.66
	Dye value	1624	2891	2305	1736	2288	1971	1502	2770	1916
4th mill juice	C. Brix	5.72	11.08	6.87	6.18	9.54	7.25	8.23	7.60	14.25
	A. purity	63.75	83.12	77.03	66.06	81.25	75.71	72.07	85.26	80.65
	Dye value	1910	3576	2789	1690	2658	2353	1965	2735	2338
Mixed juice	C- Brix	15.14	19.80	17.03	15.57	19.53	17.21	16.15	19.90	17.66
	A. Purity	74.81	93.73	85.31	68.75	86.78	80.57	74.50	92.63	85.02
	Dye value	852	1428	1156	1011	1371	1131	972	1398	1113

NOTE: CAROLINE VIRGINIA LEE

On January 5, 1931, at the home of her sister in Erie, Pennsylvania, Miss Caroline Virginia Lee went to her "long home". Sorrow and a deep sense of personal loss was felt by the whole College community at Los Baños when the cablegram came telling of the passing of our colleague, teacher and friend.

Assistant Professor Lee joined the staff of the Department of English in June, 1927. She came from China where she had taught for ten years in James Sprunt Academy at Kiangyin.

In 1929-30 Miss Lee was assistant editor of THE PHILIPPINE AGRICULTURIST. In April, 1930, she left for a year's furlough. In the last letters received from her she was already anticipating her return to us. And the faculty and students were looking forward to soon having her on the Campus once more.

In the afternoon of February 18, 1931, a service in memory of Miss Lee was held in the College Auditorium. The tribute for the church was given by Dr. James B. Rodgers, head of the Presbyterian mission in the Philippines. In addition to a warm personal tribute to Miss Lee, Doctor Rodgers read a letter from one of Miss Lee's colleagues in Kiangyin in which warm praise was expressed for her excellent work, but above all for her power and influence among the students, Dean Gonzalez spoke for the Los Baños Colleges: He said in part:

> Miss Lee was more than a teacher, for her interest in her students extended beyond the class room. In this day of gross materialism, when union hours are insisted upon, when service rendered is closely gauged with value to be received, the small army of clock-blind workers to which Miss Lee belongs has suffered a great loss.
>
> I remember very well the occasions Miss Lee came to my office for assignment of extra-curricular work. She was a rare character in that she sought work but not plaudits. The last year she was with us, the permanent head of our Department of English was on leave and her extra-curricular duties had to be divided among the personnel that remained. The choice came as to which Miss Lee would take—the more honorary one of acting head of the department or the more burdensome one of assisting in the editing of the PHILIPPINE AGRICULTURIST. She chose the latter, preferring labor to honor.
>
> Miss Lee will best be remembered on the Campus, however, for her deep interest in her students. She gave freely of her time and discussed with them their material and spiritual problems. She inspired them to greater endeavor and cultivated in them a keen sense of moral values. She contributed likewise to their material well-being. Many a student, undoubtedly some present in this gathering, will bear me out on this. Apparently her last thoughts before she departed for the Great Beyond were for her students in Los Baños, at least the last thought in which appears to be her last letter, an unfinished one, was for them. We are fortunate in having that letter with us, and with the permission of Miss

Yule, I shall read an extract from it that tells in better words than I can express her last sentiments.

> 'You cannot know how hard it was to yield to the decision of the doctors, including my sister. It seemed that my will *must* be strong enough to carry me through, but I have gone on will power just as long as I can, it seems. My heart yearns more and more for the students there as their Christmas greetings are coming in.'

This letter is unfinished and unsigned. It was sent on by her sister.

I have not known a more a conscientious worker. Her constant concern was that her efforts were not quite sufficient, and her every endeavor was to give more.

Honorio Ylizarde spoke for the students. No finer, nobler monument for a teacher could be desired than to hold the place in students' hearts Miss Lee holds as revealed by Mr. Ylizarde.

Miss Manahan sang Massenet's "Elegy". The Protestant Chape Choir sang "Near to the Heart of God", Miss Lee's favorite hymn, and "Crossing the Bar".

Caroline Virginia Lee has gone to what the Scotch so tenderly call "the long home". But the influence of her three years on this Campus will live on beyond man's estimate of delimitations.

NOTE: BAKER MEMORIAL PROFESSOR STEVENS[1]

During the eight months of residence at the College of Agriculture of Charles Fuller Baker Memorial Professor F. L. Stevens he collected more than two thousand specimens of disease-causing fungi, many of which are entirely new to science. Professor Stevens has done at the College of Agriculture the work that can best be done here on many of the specimens.

Although Professor Stevens' incumbency as Charles Fuller Baker Memorial Professor dated only from June 22, 1930 to February 22, 1931 he has already prepared several manuscripts on work completed within this period. The work on the greater part of the collection of Philippine parasitic fungi will be done in the University of Illinois when he returns to that institution some time in September, 1931. For the next two or three years Professor Stevens will be working on Philippine parasitic fungi and publishing the results of his studies on them. Thus this Memorial Professorship in its first year of operation is more than justified, or the University of the Philippines is fully compensated by the work of the incumbent not only while he is in residence at the College of Agriculture but also during the next two to three years after the expiration of his term. It is needless to say that these publications will be of very great scientific value and they will constitute an important addition to our information on the fungous flora of the Philippines.

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[1] General Contribution from the College of Agriculture No. 291.

Since the arrival of Professor Stevens in the Philippines he has published eleven technical articles.

In addition to the eleven published papers he has in press or in manuscript, ready or nearly ready for publication ten other papers.

Besides the work on more than two thousand specimens of plant diseases that will be done in the University of Illinois by Professor Stevens three titles are now well along toward publication.

The number of papers prepared by Professor Stevens since his arrival in the Philippines shows how prolific a writer and productive a plant pathologist he is.

The enormous value to Philippine plant pathology of the work of Professor Stevens during his eight months of incumbency as Charles Fuller Baker Memorial Professor of Plant Pathology is beyond question. And as a source of inspiration to the members of the Department of Plant Pathology only those who have been fortunate enough to be associated with him can appreciate.

In addition to teaching and the purely technical aspect of his work Professor Stevens gave seven very interesting and instructive public lectures to the faculty and students of the Associated Colleges, at Los Baños.

During the Christmas recess Professor Stevens accompanied by Mrs. Stevens went to Baguio. In his botanizing trips in Baguio and vicinity Professor Stevens collected more than seven hundred specimens of plant diseases in less than three weeks. While at Baguio Professor Stevens was invited to talk before the Agricultural Group of the Fifteenth National Student Conference on December 29, 1930. He spoke on plant diseases, their importance, abundance in the Philippines, and their control.

G. O. OCFEMIA,
Of the Department of Plant Pathology.

I salute the workers in physical research as the poets of today. It may be that they do not write in verse, but their communications are of such lively interest that they are on the front pages of our newspapers and command space in our cultural periodicals. They appeal to the imagination of us all. They contribute the warming glow of inspiration to industry, and when industry pulls their ideas down from the heavens to the earth and harnesses them for practical service, it too feels that it is an important actor, not only in the making of things, but on the larger stage of the human spirit. There may be enough poetry in the whir of our machines so that our machine age will become immortal.—OWEN D. YOUNG.

NOTE: BAKER MEMORIAL SCHOLARSHIP FUND

The College year which closed March 24, marked the second year of the operation of the Baker Memorial Scholarship Fund. In 1929-30 the aid from the Fund was awarded to Ambrosio V. San Pedro. In 1930-31, Engracio Basio was the recipient. According to the conditions of this scholarship aid it is awarded to a self-supporting student of the senior class. The selection of student is "on the basis of character, promise of future usefulness and scholarship."

On March 4, Dean Gonzalez issued a circular letter pertaining to this Fund. He said in part:

> The Mimics have this day increased their donation to the fund in the amount of ₱20.00, thus making their total donation ₱50.00.
>
> At the time collections were being made there were friends of the late Dean who might have not been able to give as much as they would because of temporary stringency. I know definitely of some who could not give at all at that time. The birthday of the late Dean Baker will be coming soon, and it has occurred to me that this might be an excellent way of remembering him. For those who were not able to give the first time to his favorite cause, to make contributions now, and for those who have already given, to make an additional contribution. . . .
>
> The total amount of the scholarship fund now, including the latest contribution from the Mimics, is ₱2,120.00. . . .
>
> May I invite you therefore to commemorate the birthday of the late Dean Baker on March 22 next by forwarding a small contribution to increase the Baker Memorial Scholarship Fund. Contributions may be sent direct to this office, and Mr. Alfredo V. Yñiguez, Cashier of the College, will look after the collections until we can turn them over to the Treasurer of the Fund, the Secretary of the University.

On April 10, 1931, Mr. Yñiguez reported the following contributions in response to this call.

Andelros Club	₱10.00
Rancher's Club	21.00
The "Rizal Center", Los Baños Chapter	25.00
Dr. Alexander Gordon	2.00
Mr. Constancio T. Medrana	1.00
Mr. Gonzalo Merino	20.00
Mr. Simon Perez	2.00
Mr. Alejo Taleon	2.00
	₱83.00
Previously contributed by Mimics	₱20.00
	₱103.00

The interest on this amount will add a few pesos to the aid awarded next year. The Fund is always open for contribution.

EXCHANGE NOTES

Another bright field is offered for Philippine coconuts in the announcement of the possible development of a good market for coconuts in the shell from this country in the United States. Nearly a million dollars' worth of this article are being imported every year by the United States, the bulk of the importations coming from Jamaica whose coconuts have to pay customs duty.

—*Commerce and Industry Journal* (Philippine Islands.)

A child suffering from malnutrition will not develop and will be unable to fight a serious illness, unless his condition is overcome through correct feeding. Symptoms of malnutrition or under-nourishment are: Lack of vitality, listlessness, nervousness and fretfulness, in addition to the child being delicate, thin and underweight, easily tired, with drooping shoulders, and of a dejected appearance.

—*Farming in South Africa* (South Africa.)

During the week of July 21st, there will begin a series of interesting programs over KFDM, Beaumont, broadcasting the many uses of rice to their vast audiences.

Programs will be continued indefinitely at this same hour, three days each week on the days mentioned above. Hundreds of delightful new uses for rice will be broadcast, in a novel manner by a group of characters that are destined to worm their way into your heart through their very human personalities.

—*The Rice Journal.*

Recent experiments made by the Bureau of Standards of the United States have led to the establishment in Siam by the Siamese government of a commercial paper mill with banana stem, rice straw and labang grass as the chief raw materials. The use of banana stem for the paper making is one of the latest discoveries of the U. S. Bureau of Standards. Some of its recent discoveries are the making of sugar from peanut shell and rubber from petroleum.

—*Commerce and Industry Journal* (Philippines.)

Poor vision makes you more likely to get sick when riding on cars or in automobiles, although car sickness is based on irritation of that part of your ears known as the labyrinth, Dr. J. E. Lebenhohn reports in the *Archives* *of Ophthalmology.* This distressing condition is becoming less common, however, as a result of smoother roads, easier riding cars and automobiles. People who have faulty vision or eye muscle balance are more easily nauseated if they have a digestive tract especially susceptible to further depressing influences. An empty stomach is particularly sensitive, so it is best not to fast when traveling.

—*Science-Supplement* (Dec. 5, 1930.)

A cover crop of peas and oats in a Colorado orchard was given a feed of superphosphate on half the rows. These grew more than four feet high; the others but 18 inches.

—*California Cultivator.*

We do not believe that a live stock producing community can do without a good veterinarian and in communities where a good veterinarian cannot survive if the hog vaccinating business is taken away from him, we believe that farmers would do well to enter into a fair arrangement with him to do this work rather than to take the risk of not having expert veterinary service available when it is needed.

—*The Prairie Farmer.*

Slice six medium sized tomatoes one-fourth inch thick. Have ready one-half cup of flour, one tablespoon of sugar, one teaspoon of salt and a half teaspoon of pepper, sifted together. Roll the tomatoes in the flour and fry slowly on both sides. Do not cover while cooking as they will get soft.

—*Farmer and Stockman* (Missouri.)

With an average of 798 pounds of fertilizer used on every acre of crop land during 1929, Florida leads the United States in the use of fertilizer, according to R. O. E. Davis, research chemist of the U. S. Bureau of Chemistry and Soils, speaking to members of the American Chemical Society. Next to Florida is New Jersey with 417 pounds per acre. On the whole, the states of the Atlantic seaboard use it much more extensively than those inland, though a great increase in its use has come since 1913 in the Pacific Coast States, and there is also a tendency to increased use in the West North Central states. Cotton uses on an average 108 pounds per acre, though 31 per cent of all the fertilizer used is on this crop. On citrus fruits the rate is 1163 pounds. Five principal crops consume about 82 per cent of the fertilizer, though less than 25 per cent of the acreage devoted to them is fertilized.

—*Science.*

COLLEGE AND ALUMNI NOTES

Dean B. M. Gonzalez was the commencement speaker at the graduation exercises of the Central Luzon Agricultural School at Muñoz, Nueva Ecija, on April 10, 1931.

Dr. R. B. Espino, Head, Department of Plant Physiology, was the commencement speaker at the graduation exercises of Indang Rural High School, on March 31, 1931. He spoke on what science contributes to the progress of mankind and the rôle that science plays in advancing agriculture.

Assistant Professor Anne F. Cole of the Department of English sailed April 7, on s.s. *Coblenz* for the United States via Europe, She plans to leave the ship in Egypt and go by way of Palestine to Athens, then to Constantinople, and by rail to Italy. Miss Cole expects to return to us in June, 1932.

A letter from Mr. Eligio J. Tavanlar, B. Agr. '26 to Professor Yule tells that he is teaching in the Department of Mechanical Engineering in Yale. Mr. Tavanlar went first as Cadet to West Point. Later, he left the Military Academy and studied mechanical engineering in Yale. As to whether he is combining teaching with studying Mr. Tavanlar did not state in his letter.

Mr. Engracio Basio, B. Agr. '31, has been appointed assistant in Animal Husbandry vice Mr. Dominador Pascual, B. S. A '30, who resigned to accept a more remunerative position with the Nagoya Poultry and Supply Co. at Manila. Mr. Basio was the recipient of the Baker Memorial Scholarship aid in the academic year 1930-1931.

A communication from the General Secretary of Institute International D' Agriculture, Rome, Italy, announces that the *International Year-book of Agricultural Statistics* has been released for distribution.

The volume covers about 800 pages. It "constitutes a work of the greatest importance to all those interested in questions having a direct or indirect relation to production and commerce of Agricultural Products".

In addition to data on agricultural production and distribution, live stock and commerce: "For the first time there have been introduced into the volume special chapters on the importance and distribution of the agricultural population, the distribution of agricultural holdings according to their size and mode of tenure and forestry."

A joint scientific program and luncheon of the Los Baños Biological Club and the Laguna Medical Society took place in the College of Agriculture, Sunday, March 22, 1931. The program was held in the lecture hall of the Department of Agricultural Chemistry. The President of the Philippine Islands Medical Association, Dr. Herminio Velarde, of the faculty of the College of Medicine, University of the Philippines, Manila, delivered an address of welcome. The following papers were read and discussed:

"A study of the diet of the Filipino 1930 Olympic Team" by Mr. Esteban Collado of the Los Baños Biological Club.

"General emphysema of traumatic origin", by Dr. Ricardo A. Raymundo, Secretary, Laguna Medical Society.

"Some observations on the sources of tuberculous infection" by Dr. Angel K. Gomez of the Los Baños Biological Club.

"A case of Imperforate vagina in a sexually-mature woman", by Dr. Manuel Quisumbing, President, Laguna Medical Society.

After the meeting luncheon was served in Molawin Hall.

The sixtieth scientific meeting of the Los baños Biological Club was held February 26, 1931, at 7:30 p. m., in the Lecture Hall of the Department of Agricultural Chemistry of the College of Agriculture.

The following papers were read and discussed:

"Nutritive value of balut: I. Studies on calcium" by Dr. F. O. Santos and Mr. N. Pidlaoan. Read by Doctor Santos.

"Vegetative segregation in double Hibiscus and its inheritance" by Dr. N. B. Mendiola.

The sixty-first scientific meeting of the Los Baños Biological Club, the last meeting for the College year 1930-1931, was held March 19, 1931, at 7:30 p. m. in the Lecture Hall of the Department of Agricultural Chemistry of the College of Agriculture.

The following papers were read and discussed:

"The Kawisari B coffee introduced into the College of Agriculture in 1927," by Dr. N. B. Mendiola.

"The relation to the heart rot of abaca of the *Fusarium* associated with field cases of the disease" by Dr. G. O. Ocfemia.

A report of the activities of the Club for 1930-1931 was made by the retiring President Dr. G. O. Ocfemia.

The retiring president announced Dr. Valente Villegas, President and Professor Carlos Sulit, Secretary, as the officers chosen by the Nominating Committee for the College year 1931–1932.

The following students were graduated from the College of Agriculture, University of the Philippines, on March 24, 1931:

Bachelor of Science in Agriculture:

1. Agustin, Leodegario
2. Ascalon, Salvador J., B. Agr. '31
3. Asunción, Daniel F.
4. Austria, Primo L.
5. Bagalso, Claro
6. Capco, Santiago R.
7. Capili, Justo P.
8. Coronel, Arsenio Y., B. Agr. '29
9. Cortez, Felipe B., Agr. '28
10. Creag, Geronimo Y.
11. Crisostomo, Ananias
12. Cruz, Gaudencio B.
13. Gestoso, Francisco
14. Lazaro, Enrique
15. Legaspi, Troadio T.
16. Morales, José L.
17. Padilla, Aniceto
18. Pantaleon, Feliciano B., Agr. '28
19. Roxas, Julian
20. Salvado, Severino, B. Agr. '29
21. Samonte, Honorio
22. Sonza, Isabelo, B. Agr. '29
23. Soriano, Mariano F.
24. Tingzon, Jorge A.
25. Villegas, José Miguel

Bachelor of Science in Sugar Technology:

1. Deomano, Francisco
2. Ebreo, Igmedio D.
3. Gomeri, Julian, *cum laude*
   (Bailon de la Rama Scholar)
4. Gomez, Francisco S.
5. Monsalud, Manuel R.
   (Bailon de la Rama Scholar)
6. Ramos, Cayetano
7. Santos, Amado
8. Sason, Marcelino L.
9. Sitchon, Eleazar T.
10. Tingzon, Wenceslao

Bachelor of Agriculture:

1. Basio, Engracio
   (Awarded Baker Fund Aid)
2. Caguicla, Glicerio M.
3. Calacala, Feliciano
4. Dumlao, Pantaleon
5. Espino, Herminio R.
6. Malabayabas, Gabriel P.
7. Manzon, Francisco O.
8. Soriano, Alejandro
9. Sumagui, Juan O.
10. Vega, Marcos A. de
11. Vibar, Hospicio
12. Viray, Pedro H.

For the Certificate in Agricultural Education:

1. Bandong, Tomas, B. Agr. '26; B. S. A. '28.
2. Castillo, Nicanor M., B. Agr. '26; B. S. A. '27.
3. Dawis, Vicente M., B. Agr. '16; B. S. A. '22.
4. Fabello, Sebastian F., B. S. A. '29.
5. Villodres, Serafin, B. S. A. '30

The "Joaquin J. Gonzalez Medal" was awarded to Mr. Julian Gomeri, who was graduated with degree of Bachelor of Science in Sugar Technology. This medal is awarded to the student obtaining the highest academic average for the entire course.

Summary of Registration for Summer School, 1931.

College of Agriculture:	
Regular Students	309[1]
Special Students	56
Cross Registration:	
College of Veterinary Science	3
School of Forestry	1
Total Registration	369

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[1] Four students are new registrants.

THE PRESENT EGG FEVER[1]

Of the species of poultry that are now raised in the Philippine Islands, chickens and ducks are the only ones that are considered of prime importance for the production of the eggs of commerce. Duck eggs have been produced in this country on a commercial scale from so early a period that neither history nor the memory of man records the beginning. Chickens also have been raised in this country from at least the days of the *barangay*, but until recently only on a limited scale in back yards and on the farms. As the interest in this field increases, those interested in the promotion of this industry will naturally ponder on this question: Is this interest only temporary or is it here to stay?

There is no doubt that the Philippine public is becoming poultry-minded. With an over-production of the principal agricultural crops of the country, sugar cane, rice and coconuts for instance, self-interest turns attention to the production of other crops or commodities that will insure profits. The egg is one of those products in which the danger from over-production is still remote. Hence, it is not surprising that this public interest in the poultry industry is daily becoming keener.

The Census Reports of the Philippine Islands for 1918 record that the total chicken population of the country was 12,183,127. This figure represents an increase of about 123 per cent over that of the Census of 1903, a period covering fifteen years. Using this figure as a basis, although there are sufficient reasons to show that, at least during the last decade, the rate of increase in the poultry population of the country is probably about double that reported from 1903 to 1918, there would have been about 11,939,460 female chickens in the Islands in 1930. It might be of interest for the statistician to figure out how many eggs were produced by Philippine hens even if only one-half of the female chicken population were layers, capable of producing an average of fifty eggs each during the year.

Ducks are raised in this country principally for the production of eggs, a considerable number of which are marketed as "balut". Basing calculations on the only data available regarding this branch of the poultry industry (Census Reports of 1903 and 1918), there were approximately 245,090 ducks in the Islands in 1930. Local duck raisers maintain one drake for every ten female ducks; thus at a reasonable estimate of 100 eggs each, about 22,048,000 duck eggs were produced in this country in 1930. Add this number of eggs to the number produced by chickens during the same year and the total, if not astounding, is most gratifying to egg advocates.

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[1] General contribution from College of Agriculture No. 292.

THE PHILIPPINE AGRICULTURIST, VOL. XX, NO. 2, JULY, 1931.

But notwithstanding the number of figures required to record this total number of eggs laid by our hens and ducks, the value of eggs imported into the Philippines in 1930 amounted to about ₱2,500,000. And as the population of the country increases and as the people learn more and more the importance of eggs as food, it may be expected that the consumption of eggs will increase and at a rapid rate. This will mean a corresponding increase in our egg importation unless we meet the demand by a greater rate of increase in our domestic production.

Obviously, the most logical solution to this economic problem of meeting the demand for eggs which improvement in the Filipino dietary has created is to encourage the raising of poultry in the Islands. The educational work in the use of poultry and eggs for the table should be continued with more emphasis. And along with this, instruction in the right method of producing these food products profitably should be given. The proper methods of marketing so as to secure the greatest profit for the producer and at the same time give the most satisfaction to the consumer is an aspect of the industry that also demands attention.

Undoubtedly, the news reported from a certain quarter to the effect that local duck raisers do not get as much for the eggs that they produce as they used to is a false alarm. Here is probably a clear case of faulty marketing,—somewhere along the channel of trade from the producer to the consumer there is a fault. That the present demand for eggs is great cannot be denied. The horizon of the poultry raiser was never more rosy. But a system, an organized system that will do away with unbusiness-like competition and petty jealousies among the producers themselves is needed.

The establishment of the Philippine Poultry Association should be a blessing to local poultry raisers. To how many people is this association known? The Philippine Poultry Association is an organization that deserves the sympathy and support of the public and the government authorities. Similar organizations in other countries have exerted tremendous influence in the promotion of the poultry industry. In Japan, poultry associations, financed by private individuals and receiving a subsidy from the Japanese government, have made it possible for the country of the Rising Sun to export eggs rather than to import this commodity. This remarkable change, from an importer of eggs to the value of about 18,000,000 yen to an exporter was accomplished within a space of not more than five years.

It is plain that the solution of the problems that confront the Philippine poultry industry is too great a task for any one single entity. The College of Agriculture has done more than its share in this undertaking. As is the case with other industries, money is a factor in this work. The psychological moment to extend a little help and give encouragement to those who are interested in the promotion of the poultry industry has come. The public has never shown so much enthusiasm in and for the industry as at present. Let us hope that this enthusiasm is not ephemeral, a spasm.

F. M. Fronda
Of the Department of Animal Husbandry

NEW OR NOTEWORTHY PHILIPPINE FUNGI[1]

F. L. STEVENS
Charles Fuller Baker Memorial Professor of Plant Pathology (1930-1931)

WITH THREE TEXT FIGURES

TWO INTERESTING NEW RUSTS

Aecidium ocfemianum Stevens sp. nov.

O. Pycnia punctiform, numerous, clustered, epiphyllous; when caulicolous appearing alone before the aecia.

I. Aecia on leaves mainly hypophyllous, very rarely epiphyllous, cup-shaped, 150-225 μ in diameter. Peridium well developed, white, lacerate and extending well above the leaf surface.

Peridial cells hyaline, roughened, angular to cuneiform, 24-35×17-28 μ.

Aeciospores catenulate, sub-globose to angular, minutely rough, wall hyaline, 24–28×32 μ, protoplasmic contents reddish, wall very thick, 3–6 μ.

The aecial spot on leaves shows marked hypertrophy and yellowing of the upper surface. They are usually less than a centimeter in diameter. On stems and large veins there is often much hypertrophy, figures 1a and b, and the galls may be several centimeters long. When on young shoots the whole shoot and its leaves hypertrophy and is first covered with pycnia and later by aecia which are scattered and about a millimeter apart.

On *Pisonia alba*[2] Span.

Collected at Sariaya, Tayabas, Philippine Islands between kilometers 123 and 124 by Dr. G. O. Ocfemia, August 9, 1930 on the same plant that later bore *Uredo ocfemiana.* Stevens' specimen No. 198. Named in honor of Doctor Ocfemia of College of Agriculture, Los Baños, in recognition of his many services to plant pathology and mycology.

This species differs from *Aecidium pisoniae* Arth. and Johnst. described as on *Pisonia aculeata* from Cuba in the thickness of the epispore wall and in having larger and more angular spores of orange colored content. In a letter under date of October 25, 1930, Dr. J. C. Arthur who has examined both specimens says they clearly are different.

Uredo ocfemiana Stevens sp. nov.

Sori often solitary, sometimes grouped, usually hypophyllous, rarely epiphyllous.

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[1] Experiment Station contribution No. 722. Received for publication, March 4, 1931.

[2] *Pisonia alba* Span. is often planted as an ornamental and in various places the leaves are used for medicinal purposes.

Spores globose or very slightly ovoid, 28 μ in diameter, with numerous hyaline spines, 3–4 μ tall; contents orange colored, wall hyaline, thick.

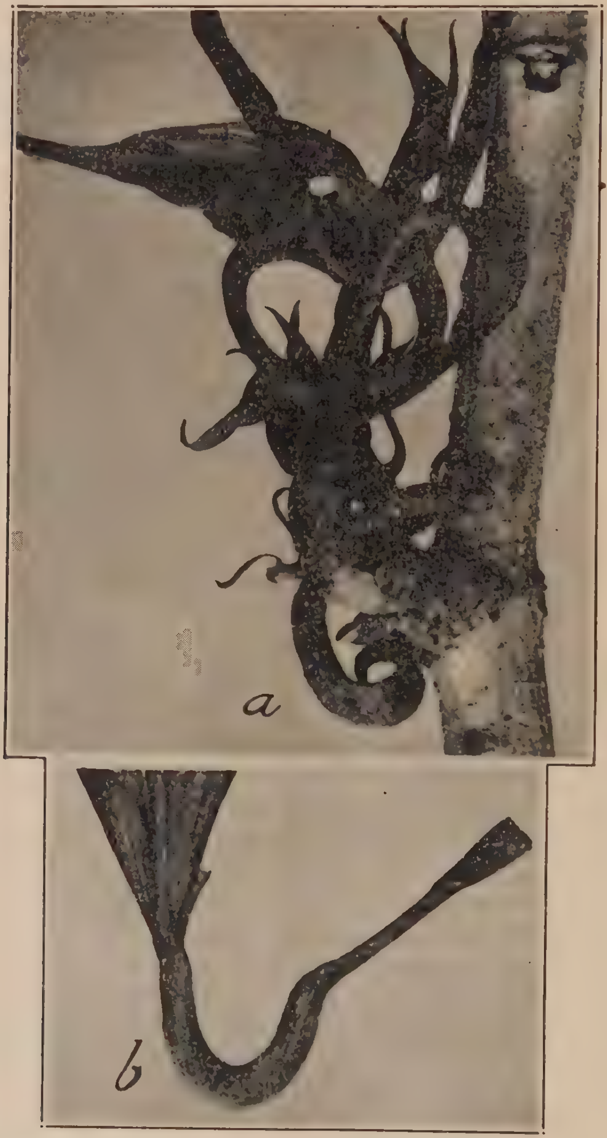

Fig. 1.—*Aecidium ocfemianum*, (*a*) showing hypertrophy and distortion of a shoot. Slightly enlarged. (*b*) Hypertrophy of the petiole. Slightly reduced (Photograph by the Photographic Division, Soils Department, College of Agriculture, Los Baños.)

Spots on the leaves often minute, 0.5 mm., barely showing as yellow indefinitely bordered areas from above and from below as red sori. There is no hypertrophy. (Fig. 2.)

On *Pisonia alba* Span.

Collected at Sariaya, Tayabas, Philippine Islands between kilometers 123 and 124 by Dr. G. O. Ocfemia, September 14, 1930, on the same leaves with *Aecidium ocfemianum.* Stevens' specimen No. 595. Named in honor of Doctor Ocfemia of College of Agriculture, Los Baños, in recognition of his many services to plant pathology and mycology.

These two rusts are obviously connected. In the earlier collection there were numerous aecia on both stems and leaves and no uredinia. In the later collection the aecia had ceased to function and the leaf surfaces were covered with uredinia. A collection made as late as November 9 showed no aecia, but many uredinia. Careful search was made with the hope of finding telia, but none could be found.

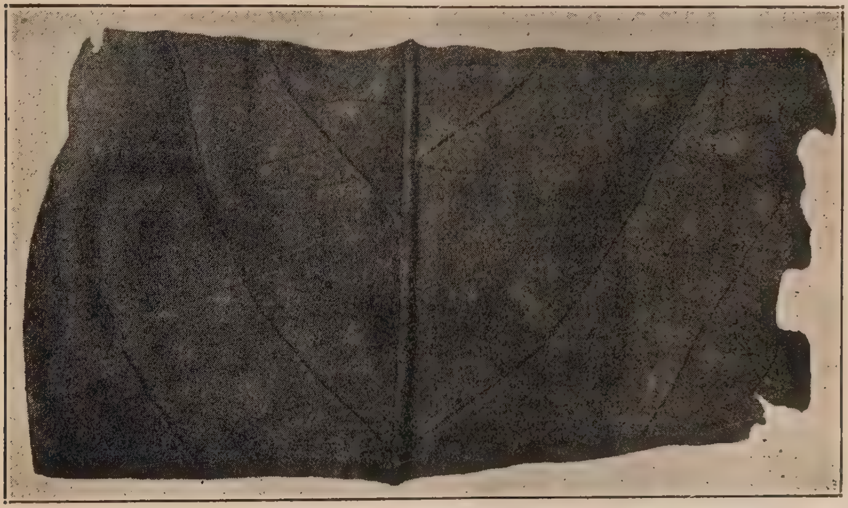

Fig. 2.—*Uredo ocfemiana*, showing sori on the leaf. Nearly natural size. (Photograph by the Photographic Division, Soils Department, College of Agriculture, Los Baños).

The uredospores germinate by a long germ tube with reddish granular protoplasmic content.

The aeciospores germinate either in hanging drop or on agar by long germ tubes.

THREE INTERESTING ENTOMOGENOUS FUNGI

Empusa grylli (Fres.) Nowakowski

The occurrence of this interesting parasite of grasshoppers in the Philippines is first recorded in the *Philippine Agricultural Review* **6**: 546, 1923, as on *Pachytylus migratoroides.* The fungus has doubtless been collected several times and in several different localities. *Empusa* is a genus of comparatively few species and is always parasitic on insects and often serves to lessen their abundance to considerable extent. Almost no reports have been made from the Philippines of fungi of the family Entomophthoraceae to which *Empusa* belongs.

The photograph (fig. 3a) accompanying this note and several specimens were furnished by Mr. G. M. Reyes, Assistant Mycologist of the Bureau of Science at Manila and the determination was made by Dr. Roland Thaxter of Harvard University.

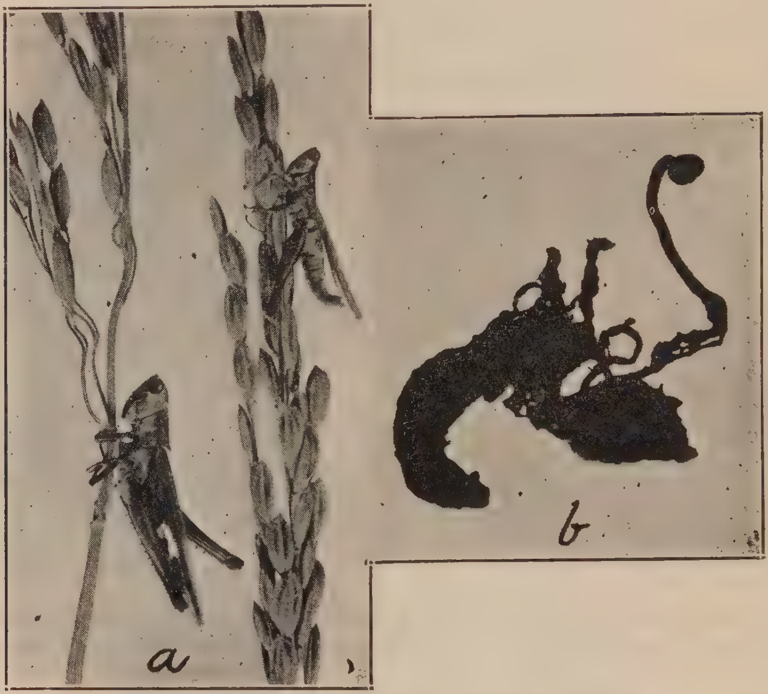

Fig. 3.—(*a*) Portions of rice panicles showing grasshoppers killed by *Empusa grylli*. (*b*) A dead white grub (*Leucopholis irrorata* Chevrolat) showing *Cordyceps podocreoides* von Höhnel in sporing condition. The specimen was collected in Negros Province and sent to the author by the Director of the Bureau of Plant Industry.

Cephalosporium crassum Petch

This interesting parasite of the abacá (*Musa textilis* Née) and banana (*Musa sapientum* L.) aphid *Pentalonia nigronervosa* Coq. was discovered by Dr. G. O. Ocfemia of the College of Agriculture, Los Baños, in 1930 and it was described and named by Dr. T. Petch in the Transactions of the British Mycological Society from specimens communicated to him by Doctor Ocfemia. The fungus is quite abundant on the aphid on *Musa* spp. and doubtless to some extent checks its advance.

Cordyceps podocreoides von Höhnel

This fungus parasitic on white grubs *ulalo*, or bucan (*Leucopholis irrorata* Chevrolat) of sugar cane (*Saccharum officinarum* L.) collected from the island of Negros of the Visayan Islands and sent to the writer by Dr. M. L. Roxas, Director of the Bureau of Plant Industry, seems to be common and certainly kills large numbers of the grubs (fig. 3b.) The first specimens of this fungus from which the determinations were made by Doctor Petch were collected by Dr. L. B. Uichanco of the Department of Entomology, College of Agriculture, in January, 1929 from Patay na Ilog, Cabuyao, Laguna.

Cordyceps is a genus of more than 70 species and is always parasitic upon insects or subterranean fungi.

A SURVEY OF IRRIGATION PRACTICES IN THE RICE INDUSTRY OF CALAUAN, LAGUNA[1]

A. L. TEODORO AND EUSEBIO BATACLAN[2]
Of the Department of Agricultural Engineering

An area of approximately one thousand hectares is yearly worked for the culture of lowland rice in Calauan, Laguna. For more than one hundred years, farmers in this section have raised this crop with the aid of artificial irrigation.

The town is located near the base of a small mountain. The rice section is nearly level and is provided with a river which supplies water throughout the year.

CLIMATE

The region has heavy rainfall, hot dry seasons, and variable wind movements. There is seldom rainfall during February, March, and April. The heaviest rains are from July to November. . The average annual rainfall is about two meters and the mean annual temperature about 25.5°C. The highest temperature occurs from April to August, inclusive, varying from 30.2°C. to 35.8°C. The usual minimum temperature is about 23°C.

SOIL

The larger part of the rice crop is grown on a brownish-black, loamy-clay soil. When wet, this soil is sticky and when dry it breaks at the surface into clods of different size and shape. The cracks vary from one millimeter to about two and a half centimeters in width. The subsoil which is mostly of brownish yellow adobe lies at a depth varying from about 35 centimeters to more than a meter. It is believed that in some fields the subsoil is almost impervious.

SOURCES OF IRRIGATION WATER

The river that crosses the town supplies the larger portion of irrigation water. Rainfall provides a portion of the water necessary to mature the crop in high areas and in places where brush dams do not function well.

The water is taken out of the river by gravity. A large concrete dam was built at a high point above the river to divert the water into two large diversion canals. A number of small brush dams was built in these canals to supply water to two or more laterals.

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[1] Experiment Station contribution No. 723. Received for publication, April 27, 1931.

[2] Mr. Bataclan resigned from the position as graduate assistant in mathematics in July, 1929.

Nearly all the fields are portions of the large estate of Calauan. The estate farm land is divided into small areas varying from a half hectare to as high as five or seven hectares. All these fields receive ample supply of irrigation water under favorable conditions.

There are not many permanent devices used for raising and for distributing the water. Temporary gates hardly last a season; they are destroyed or broken. The losses from leaks, seepage, and washouts, are great.

DISTRIBUTARIES AND LATERALS

Water is conveyed into the paddies by means of a distributary that is made of two parallel levees each about 30 to 55 centimeters high and 30 to 100 centimeters apart. The bottom of the distributary is usually below the surface of the soil in the paddy. More water than is used is necessarily run into the ditch, thus causing great loss in evaporation and in seepage.

The distributary is usually constructed between a row of paddies numbering from five to fifteen. The water is brought to the highest point of the field and carried down to the paddies by gravity. The distributary connects with the lateral which runs down the slope of the field through one of its sides or through its center.

The number of laterals and distributaries varies a great deal on the different farms. A system of irrigation ditches appears in places where the contour of the land is not uniform. Fewer and shorter laterals are found in nearly level areas.

PADDIES

The farm is divided into several paddies, the size and shape of which vary depending upon the contour of the land and upon the availability of water supply. In places where the slope is moderate the paddies are almost uniform in size and in shape. On level areas they are square. Smaller paddies are very common in places where the supply of water seems scanty.

Filipino farmers very rarely make long and wide paddies even in the fields where the contour of the land and the amount of water favor the scheme. They usually divide the farm into as many small paddies as possible so as to maintain a uniform depth of water throughout. The number of paddies built on a hectare varies from eight to twenty.

LEVEES

Each paddy is inclosed by levees, or dikes to hold the water that is run into it. A paddy levee usually measures about 50 centimeters at the base, 20 to 25 centimeters at the top, and 25 to 40 centimeters high. A levee of larger size is used to inclose the field.

In constructing new levees, the farmers usually build first the ones that go nearly in the same direction as the natural flow of the water in the field.

This divides the fields into big paddies running down the slope of the farm. Cross-levees are constructed to divide the big checks into small paddies.

Levees are constructed for every drop of from three to twenty centimeters. On steep slopes they are generally broad and high and are made with a drop reaching as high as half a meter.

The different levees are located and built without the assistance of any licensed or professional surveyor or engineer. What a farmer needs in time of preparation is plenty of water for leveling, and a number of helpers. Levees for new farms are usually built at least a month before planting. Sufficient time is allowed for settling and for hardening. Repairing of levees on old farms is done yearly at the time the paddies are prepared. All the levees are repaired before planting.

In preparing a new levee it is the practice to plow first the moist ground to a width of from 80 to 120 centimeters. This is done in order to provide for a good foothold for the new levee. It may be necessary to first soak the ground with water to make it soft and sticky. The wet soil is then thrown into the levee either by hand or with the aid of a native harrow. Very often weeds are wrapped with mud for the purpose of filling low spots. The bolo is the principal tool used for shaping and for trimming the sides.

Water is not allowed to stand deep on either side of the levee until it is well set and completely finished. When the rice paddies are planted, the farmers try to keep the grass and weeds from growing too abundantly on the levees. The dikes are not used for footpaths until they are hard and dry.

HOW THE PADDIES ARE FLOODED

Each paddy is usually provided with two gates, one intake and one outlet. These gates are openings cut temporarily on the levees by the farmers. The intake is usually located on the highest point of the paddy. In general the outlet of one paddy serves as the intake for the next lower paddy. In some fields, the farmer arranges all the gates in one straight line so as to locate them easily.

The size of the gates determines the amount of water entering or leaving the paddy. The usual practice is to make the gate about as wide as the farmer's foot is long. It is necessary to keep a close watch on these openings, as they wash out and the amount of water that enters the paddy will be so great as to spoil the crop.

GROWING SEASON AND VARIETIES OF RICE GROWN

A certain field may be planted just once a year with a certain variety of rice or with another variety it may be planted twice a year. The Binambang which is a long maturing variety is the one generally grown once a year. The growing season for this is from August or September to February or March. The Binicol and the Guinangang are early maturing varieties and are usually grown twice during the year. The growing seasons are from May or June to October (crop) and from November or December to April (crop). These periods include the time of land preparation to harvesting of the grain.

LAND PREPARATION

The time of land preparation varies from four to seven weeks. When a second crop is to be grown, the maximum time alloted does not exceed thirty days. The farmers found by experience that when the planting is done later than the month of December the plants do not bear panicles. This was the result of the observations made by the farmers on the Binicol and Guinangang varieties. Data are not available regarding the behavior of other varieties of rice when planted later than December.

The preparation of the land consists principally of weeding, plowing, harrowing, and of repairing or making of levees. Weeds generally grow abundantly in the fields that are not planted with two crops a year. The cut weeds are either burned or are allowed to rot in the fields depending upon the weather condition. Weeding is done about a month before plowing. When no weeding is done the old rice stubble is first burned before the land is plowed.

The land is generally soaked with water, either by rain or by artificial irrigation before plowing. It is found to be very convenient to soak the upper layer of soil at least ten centimeters deep. One plowing is all that is necessary in some fields. Other fields are plowed twice, the second plowing being done in a direction cross-wise to the first. It is the aim in the second plowing to turn over the soil completely. When plowing the farmer usually covers two to five paddies in one course. The land is plowed to a depth varying from 9 to 15 centimeters.

After the land is plowed, water is admitted into the paddy until all the soil particles are completely covered with it. The farmer tries to keep the newly plowed soil submerged from five to eight days. The water may be kept either slowly running or stagnant, depending upon the supply.

The first harrowing which is called *basag* is done usually one week after plowing. The water in the paddy is lowered a little before the work starts. It is the aim in this harrowing to break the soil further into as small particles as possible and to destroy the roots of weeds which may have started to grow.

In harrowing, the farmer tilts the harrow handle back until a reasonable amount of trash is gathered. A downward thrust buries the weeds under the mud. It is not uncommon for the farmer to use his feet in burying these weeds which the harrow fails to cover.

The farmer runs his harrow twice over the same place before he takes a new course. The surface of the paddy is uneven after the first run on account of the tilting and of the thrusting of the harrow. In the second run, the farmer usually tries to level the surface. Water is admitted into the field to a depth of about 10 centimeters. This depth is maintained from three to eight days depending upon the amount of water and upon the season. Only one paddy is harrowed at a time.

The depth of the water in the paddy is lowered one-half before the second harrowing starts. This harrowing is called the *balasao*. The object is to further pulverize the soil and bury the weeds. Two runs are necessary before a new course is taken. This harrowing is run in the same direction as the *basag*. Water is again admitted to a depth of about 10 centimeters. This depth is maintained from three to five days.

Before the third harrowing, called the *halang*, starts, the water in the paddy is lowered until the surface is just barely covered. The harrowing is run in a direction cross-wise to the second and the soil is further pulverized. The field is made nearly level and the weeds are buried deeper. Water is admitted to a depth of about five centimeters after this harrowing and is maintained from 3 to 5 days.

The fourth harrowing which is called the *pantay*, is run in the same direction as the first and second harrowings. Careful leveling is made at this stage. After this harrowing the water is drained off, and the paddy is kept in as *labladdy* a condition as possible. The seedlings are planted immediately after this harrowing.

TREATMENT OF SEEDS

Two systems are generally used for treating the seeds; namely, the *dapog* and the *sa panahon*. The dapog system is practiced when the variety grown is either Binicol or Guinangang, and the *sa panahon* when Binambang is raised.

The dapog system. The seeds are put in a sack and soaked for 48 hours in slowly running water. For another 48 hours, the sack is kept on a support which is usually located under a tree that gives a dense shade. Or the seeds, after being soaked, may be put on a mat or other container and placed under shade for the 48 hours. When treated in this manner, the seeds are pressed by means of a weight. Very often the seeds are mixed thoroughly in the open air before being transferred. The approximate amount of seeds used for a hectare is about a cavan, (75 liters).

A few days before the seeds are treated, the seed bed which may cover an area of a fraction of a paddy, a paddy, or two paddies, is prepared. It is plowed and harrowed in exactly the same manner (only more carefully) as the field is prepared. It is always planned by the farmers to plant the seed bed ten days before the transplanting time.

After the seeds have been for 48 hours in shade, they are sown on the seed bed. Banana leaves are first laid on the top of the bed with about a centimeter thickness of mud on them. The seeds are sown thickly on this layer of soil. The surplus water on the seed bed is drained of. For 10 days, the bed is carefully irrigated, admitting the water only at times when the soil appears dry and cracking. The water is applied to such a depth that the seeds are not drowned. The irrigating is mostly done at night. The frequency of irrigation depends altogether upon the weather condition.

When the seedlings are about 10 centimeters high they are ready for transplanting. They are removed in bunches of a size big enough for a man's hand to handle. The seedlings are planted in the muddy field, allowing an approximate distance of from 18 to 25 centimeters each way.

Men, women, and children are employed in the transplanting. The number in the group ranges from 25 to 100. A man can plant approximately 400 square meters a day.

Provisions are made by the farmers to drain off the surplus water in the field after planting.

TABLE 1

Planting plan for rice in Calauan, Laguna

	METHOD OF SEED TREATMENT	VARIETY OF RICE	PREPARATION OF LAND	PLANTING OF SEEDLINGS	HARVESTING
			months	*months*	*months*
Palagad, or rainy season	Dapog	Binicol or Guinangang	May or June	June	October
Dry season	Dapog	Binicol or Guinangang	November or December	December or January	April or May
Sa Panahon	Sa Panahon	Binambang	August or September	September or November not later than December	February or March

The panahon system. The *panahon* system differs from the *dapog* in the number of days the seedlings are kept in the seed bed. The seeds are soaked in water and are laid in shade for a period of four days. They are directly planted to the bed and not on a layer of soil placed above the banana leaves. The seed bed is made a little higher in the middle than at the sides for perfect drainage. For six to seven weeks the seedlings are carefully irrigated. The amount of water admitted is only enough to moisten the bed. Great care is taken not to overdry the bed and thus spoil the seedlings.

Before the seedlings are transplanted portions of the leaves are cut off to prevent too much transpiration after they are planted. Seedlings planted later than seven weeks after the seeds are sown in the bed are not likely to produce a good crop. Farmers consider, as old, a seedling that has produced one node.

IRRIGATION

An intermittent method of irrigation is used in all fields. The number of irrigations varies from four to eight. The greatest factors affecting the frequency of irrigation are variety of rice used, date of transplanting, growing season, weather condition, amount of water supply, kind of soil, and prevalence of weeds.

Soon after the seedlings are transplanted, the field is drained for a period of from two to five days. The first irrigation comes as soon as the surface shows sign of cracking from dryness. Water is admitted to a depth which varies from five to ten centimeters. This irrigation lasts from one to two days. The water entering the field is kept slowly running so that it may wash the mud from the seedlings and remove any surface trash. The fields are again drained for about three or four days.

The amount of water used in the second irrigation is from one to two centimeters deeper than the first. This period lasts from three to five days. This irrigation is followed by a period of drainage varying from three to five days. In the third irrigation the depth of the water in the field is again increased by about two or three centimeters. The field is kept drained from three to seven days after this irrigation.

Where the field receives eight irrigations the depth of water applied in the fourth, fifth, and sixth is usually increased by about one centimeter over the preceding depth. The period of irrigation is about four days for the fourth and the fifth. The fields are kept drained for almost the same length of time. The sixth drainage lasts for about a month and the seventh about a week. A constant depth of water (about 16 centimeters) is maintained from three to four weeks in the seventh and in the eighth irrigations. The fields are kept drained until the grain is harvested.

When the number of irrigations is reduced to seven, there is practically very little change in the depth of water run into the field. Approximately 15 to 16 centimeters of water is used for each irrigation starting on the fifth. The fields, however, are drained for about 30 to 35 days in the fifth and from 6 to 11 days in the sixth. The sixth irrigation lasts from two to three weeks, and the seventh about four weeks.

When the field is irrigated for less than seven times, the farmers generally use a longer period for irrigation and for drainage from the time the seedlings are transplanted till the third or fourth irrigation. The depth of water applied is gradually increased up to the third irrigation and is gradually decreased to the fifth or sixth. The fields are irrigated from ten to twenty days in the last irrigations and are kept drained five to eight days longer. This kind of irrigation is practiced only at times when the water supply is not sufficient.

There are now a number of farmers that practice flooding the field soon after the rice is harvested and all the grain is safely stacked. This practice is usually followed on farms where only one crop is grown during the year. Water is admitted into the fields to soak the surface of the soil. It is plowed and covered with water immediately after plowing. Rain may supply all the water that is necessary during this time. The field is then allowed to remain idle until the next growing season.

SUMMARY AND CONCLUSIONS

This survey shows that there are actually two periods in which water is needed for irrigation of rice in Calauan, Laguna. The first period, comprising the land preparation, requires a constant supply of water for soaking and for puddling the fields for a period varying from 38 to 50 days. The greatest amount of water is used when the fields are being puddled before they become set. Approximately twenty centimeter-hectare is needed in the second and in the third harrowings. The water is most needed during the period of intermittent irrigations in which approximately 15 centimeter-hectare is constantly needed for more than a month. The total number of days in which the plants were kept submerged intermittently from the time of the first application of water until it is removed to permit harvest, varies from 55 to 65 days. The average length of the growing season from transplanting to harvesting is about 115 days.

The irrigation program here discussed which deals with the frequency of irrigation and the amount of water applied depends wholly upon the various stages of the growth of the variety of rice grown. Effects of other factors undoubtedly will alter the irrigation and drainage methods.

In the maintenance of the irrigation system there should be a strong coöperation not only in the distribution but also in the timely application and removal of water. Some sort of permanent measuring devices and gates should be established to provide better control of water and to insure just distribution. The use of temporary dams and gates should be minimized to avoid too much loss.

THE KAWISARI B COFFEE INTRODUCED IN THE COLLEGE OF AGRICULTURE[1]

N. B. MENDIOLA
Of the Department of Agronomy

WITH SIX TEXT FIGURES

What is the Kawisari B coffee? The Kawisari B coffee (also written as Kawisarie B) is a natural hybrid between *Coffea arabica* Linn. and *Coffea liberica* (Hiern.) Bull. It is said that in an estate in Java called Kawisari, there were grown at one time only Liberica and Arabica trees. From seeds of Liberica trees there arose certain plants which were different from the parents and which proved to be natural hybrids. At least two of these hybrids have proved commercially valuable. They are known as Kawisari B and Kawisari D hybrids. The Kawisari B is considered a better hybrid than the Kawisari D. The most important characteristics of these hybrids are that they are practically immune to the attack of coffee rust (*Hemileia vastatrix* Berkeley and Broome) and that they give coffee which is second only to Arabica in quality and commands a better price than Liberica, Robusta and other commercial varieties except Arabica.

Other points in favor of these hybrids, according to Wester (1916), are strong vigorous growth, ability to endure unfavorable climate and soil conditions better than other coffees, and that they are constant croppers. It is said that they yield from 500 to 600 kilograms of coffee per hectare, and that 8.5 kilograms of fresh berries are required to give one kilogram of market coffee. While they grow successfully under the same conditions as the Liberica and Robusta, Kawisari B is best for altitudes above 350 meters and Kawisari D for lower elevations.

As might be expected, Liberica-Arabica hybrids evidently have inherited from their Liberica parent some of its undesirable characteristics. For example, as in the case of Liberica, their berries require artificial drying to make possible the easy removal of the silver skin. Market coffee with the silver skin on brings a much lower price than the same variety of coffee with it removed. The silver skin can be easily removed from Arabica coffee dried in the sun. Friederichs (1924) reported that these hybrids are more susceptible to the attack of the coffee-bean borer than the coffees of the Liberica group. However, to compensate for this disadvantage, he reported that the fungus parasite of the borer exists in greater abundance on these hybrids than in other coffees.

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[1] Experiment Station contribution No. 724. Read before the Los Baños Biological Club, March 19, 1931. Received for publication, March 27, 1931.

Other known natural hybrids in Java between the Arabica and Liberica coffees are the Kalimas and the Soember Sengkarang.

Difficulties of introduction. For a long time in the Philippines, we had been hearing about the Kawisari coffees but had not seen them. Very early in the history of this College, many of the commercial varieties of coffee had been introduced here (David, 1928), but not the Kawisari hybrids, or any of the Liberica-Arabica hybrids for that matter. The main reason for the long delay in the introduction of these hybrids is probably the difficulty which is met in the introduction.

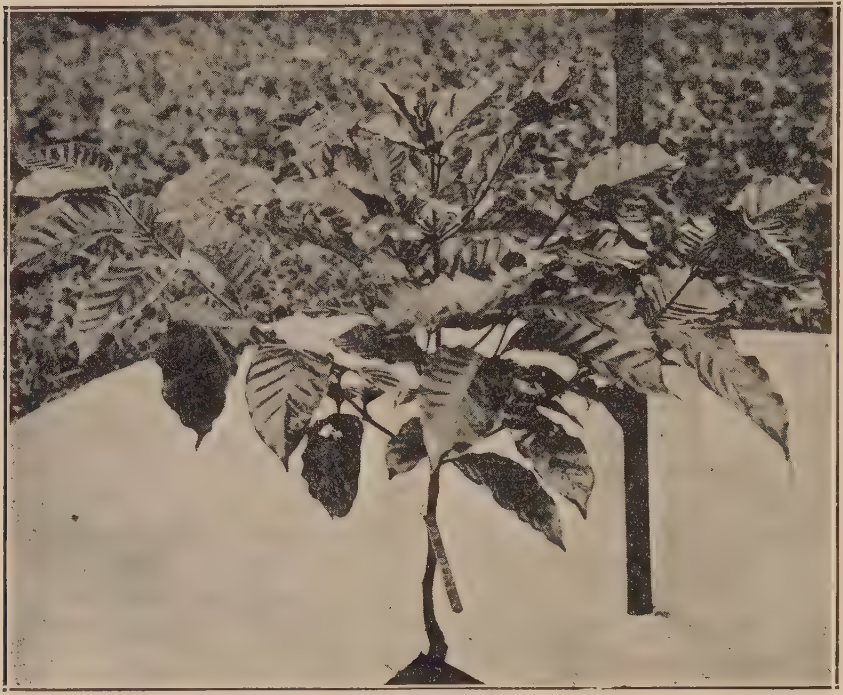

Fig. 1.—A Kawisari B plant (grafted) about 1½ years old.

Being hybrids, their seeds do not come true to type. For this reason they have to be propagated vegetatively to obtain a uniform planting. Hence, any attempt to introduce these hybrids by the usual method of importing seed is bound to fail. The only way by which the hybrids could be brought here is by introducing scions or living plants, and to do this from Java is not easy. So it is not surprising that our coffee collection has not been graced earlier with the presence of these hybrids. It is probably for this reason, also, that we hear or read nothing about the existence of these Java coffee hybrids in any of the other coffee-growing countries.

It is of historical interest to note here that in 1912 the feasibility of importing these hybrids into the Philippines was ascertained by Mr. P. J.

Wester who brought to Manila several samples of scions, but according to his report, in spite of the care with which they were packed, all of the scions died several days previous to their arrival.

In 1917, Mr. C. C. Batchelder of the Philippine Government who was sent to Java in 1916 to make an investigation about the coffee culture in that country, stated in his report (Batchelder, 1917) that the introduction of these hybrids into the Philippines did not then seem necessary. It is unfortunate that such a statement was made, for if he had recommended the introduction of these hybrids in that year and such an introduction had been made successfully, much could have been done in the way of their propagation during the more than fourteen years which have elapsed since.

Object of this paper. It is the object of this paper to present a brief report on the Kawisari B plants which were introduced into this College from Java more than three and one-half years ago. Since their introduction these plants have been under close observation to determine if there is promise in this hybrid under Philippine conditions and if it would be desirable to begin with its large scale propagation.

INTRODUCTION AND CULTURE OF THE KAWISARI B COFFEE IN THIS COLLEGE

The introduction. When the author returned to this College on August 23, 1927, from a stay of several months in Java he brought with him three Wardian cases and several boxes full of plants from that country and also from Kuala Lumpur, Federated Malay States. Many of the Java plants were given as a courtesy to this College by the General Agricultural Experiment Station of Java, and two of these plants were budded Kawisari B plants. Upon arrival, these plants were planted near Cottage No. 5 on Faculty Hill where they have been growing ever since.

The culture. The place where these plants are growing has an elevation of about 80 meters. The location from where they came in Buitenzorg, Java, is 236 meters above sea level. This hybrid is grown on a large scale at other altitudes in Java.

From the cultural standpoint, the soil in which the College Kawisari plants are planted is not as good as that in Buitenzorg. The local soil is of the tuff variety, shallow and underlaid with a hard pan. The plants are shaded about half of the day. Because of the possible value of these plants in Philippine agriculture they have been taken care of better than are coffee plants in ordinary culture. They have been watered from time to time and the place where they are growing has been kept free from weeds practically all the time.

For purposes of record the two plants were designated as plant No. 1 and plant No. 2. Plant No. 2 was pruned on July 11 and 18, 1929 for materials for vegetative propagation.

RESULTS OF OBSERVATION

General vigor. As may be seen in figures 1, 2, and 3 the Kawisari B plants under report have grown vigorously. When they arrived at the College, plant No. 1 was 30.4 centimeters high and No. 2 was 25.5 centimeters. They were then about four months old. At the present writing, when they are nearly four years old, plant No. 2 is about 2.5 meters in height.

First flowering and fruiting. Plant No. 1 began to flower a little over a year after arrival at the College. The first harvest was made on December 8, 1929, that is, about two years and four months after introduction, or at the age of two years and six months.

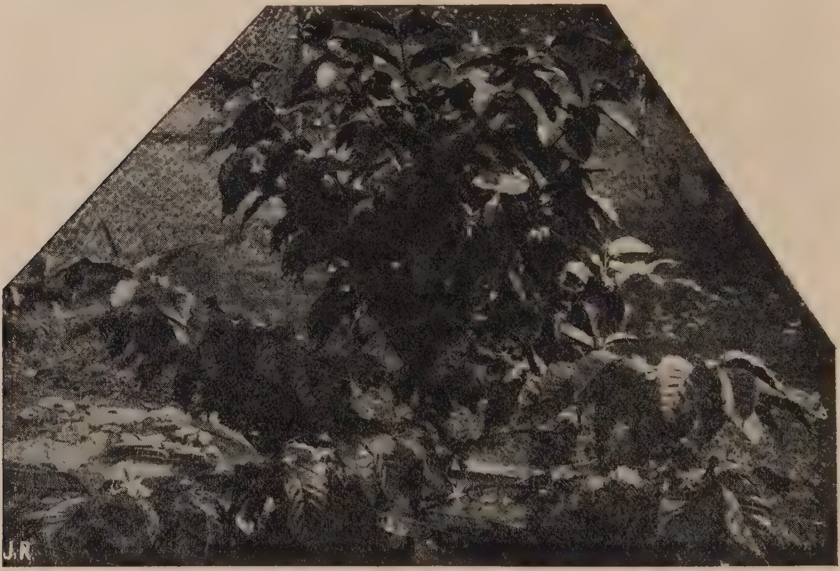

Fig. 2.—Kawisari B plant (No. 1) at age of 2¾ years.

Yield. Table 1 gives a record of monthly yield of the two Kawisari B plants up to date. This table shows that plant No. 1 gave a total of 1.55 kilograms of fresh berries the first year, which happened to be 1930, not including the very first harvest of 36.4 grams in December of 1929. This total yield would have been somewhat higher had not a branch bearing 31 berries broke off on November 27, 1930.

For the months from October, 1930 to and including February, 1931, when plants No. 1 and No. 2 were yielding without interruption, the yield was about the same for both plants; namely, 1570.1 grams of fresh berries for plant No. 1 and 1572.6 grams for plant No. 2. Considering that this yield is only for the first year, it compares favorably with the yield of other varieties. The average yield per tree of other varieties growing in this

College, according to our record for three years, is as follows: Excelsa, 2.702 kgm.; Robusta, 1.702 kgm.; Quillou, 1.645 kgm.; and Liberica 4.068 kgm.

Harvesting period. The harvesting period in the College for the old varieties of coffee covers the months from November to April. It will be noted in table 1 that for the Kawisari coffee, the harvesting period extends practically throughout the entire year.

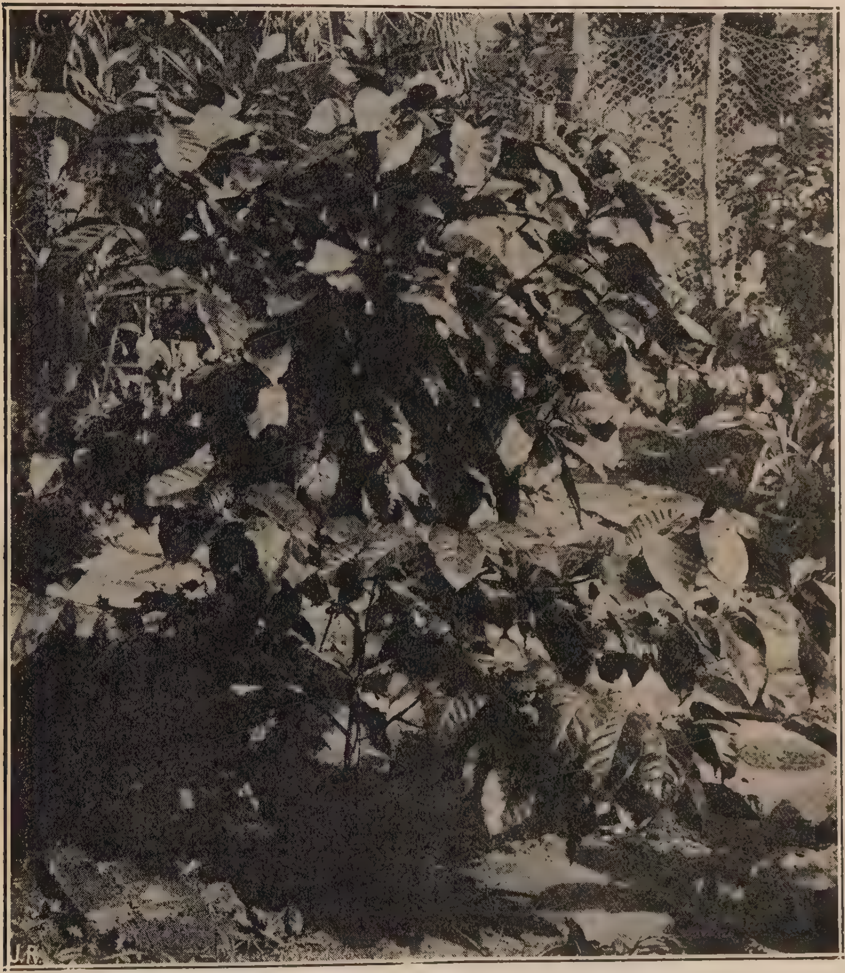

Fig 3.—Kawisari B plant (No. 2) at age of 2¾ years. Pruned at age of 2½ years.

The berry. The Kawisarie B berries are usually red but sometimes are yellow when ripe. In a study of about 100 berries it was found that the diameter of the berry varied from 1 to 2 centimeters and the length from 1.5 to 3 centimeters, and that the average diameter was 1.66 centimeters and the length, 1.90 centimeters. In one ganta of berries of Kawisarie B there are about 720 berries, of Robusta 2290, of Excelsa 624, and of Liberica 458, showing that they are larger than Robusta berries but smaller than those of Excelsa and Liberica.

TABLE 1

Yield of Kawisari B Coffee plants in the College of Agriculture

MONTH	1929		1930		1931	
	PLANT NO. 1	PLANT NO. 2	PLANT NO. 1	PLANT NO. 2	PLANT NO. 1	PLANT NO. 2
	grams	*grams*	*grams*	*grams*	*grams*	*grams*
January			210.0		326.2	579.9
February			38.3		60.7	281.0
March			15.8		131.4	328.2
April			15.4			
May			——			
June			32.9			
July			41.8	3.7		
August			12.9	——		
September			——	——		
October			498.1	204.9		
November			415.0	190.8		
December	36.4		270.1	316.0		
Total for year	36.4	——	1550.3	715.4		

Number of seeds in a berry. In a count of seeds of 1578 berries, there were found 725 berries with single seed and 854 berries with double seed.

TABLE 2

Relation of weight and volume of fresh berries to weight of market coffee for different varieties determined from harvests in the College of Agriculture

NAME	WEIGHT OF FRESH BERRIES REQUIRED TO PRODUCE 1 KGM. OF MARKET COFFEE	WEIGHT OF MARKET COFFEE PRODUCED FROM 1 KEROSENE CAN OF FRESH BERRIES[a]
	kgm.	*kgm.*
Arabica[b]	5.00	——
Excelsa	5.82	2.112
Robusta	4.31	2.964
Liberica	9.90	1.242
Canephora	4.00	——
Quillou	3.99	——
Abeocuta[c]	8.00	——
Kawisari B	6.13	1.762

[a] One kerosene can when full = 20 liters.

[b] Batchelder (1917).

[b] Wester (1916).

Relation of weight of fresh berries to weight of market coffee. This relation is the quality ratio in coffee and is usually reckoned as number of kilograms of fresh berries needed to produce a kilogram of market coffee,—that is, dry seed free from parchment and with little or no silver skin. Table 2 shows the quality ratio of Kawisari B of the College and of other varieties, the latter as computed from Ramos (1928) data.

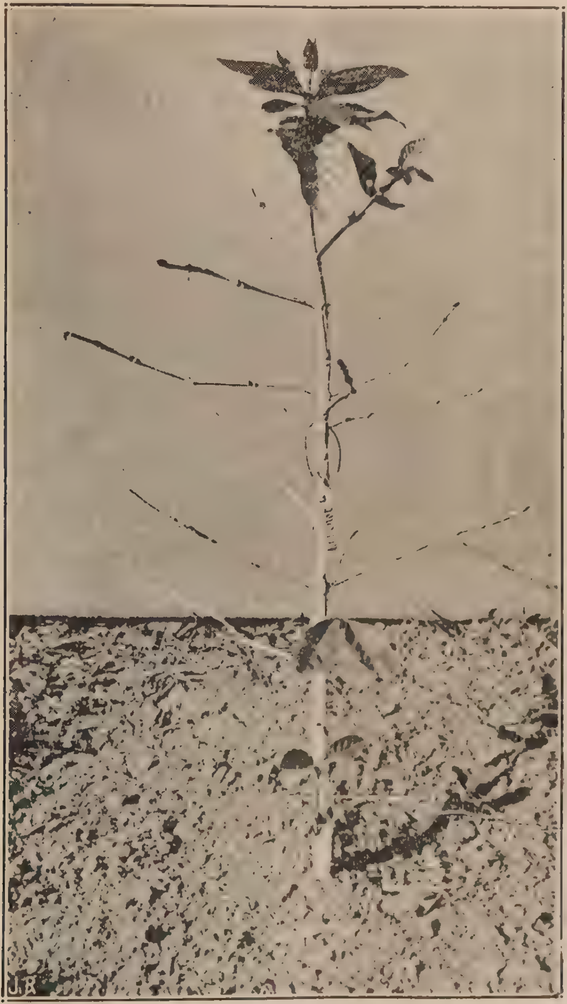

Fig. 4.—A Bourbon coffee seedling showing defoliation due to *Hemileia vastatrix.*

Ratio of volume of fresh berries to weight of market coffee. The expense of cleaning fresh berries ready for market coffee depends upon the volume of raw material. In the Philippines, this expense is reckoned as so much per kerosene can. Table 2 also shows the weight of market coffee which is obtained from a kerosene can of fresh berries of Kawisari B and of other commercial varieties of coffee.

Resistance to the coffee rust. The Kawisarie hybrids are noted for their high resistance, if not practical immunity, to the most serious disease of coffee, the coffee rust. It appears that this resistance is likely to prevail even under our conditions, at least in the case of Kawisarie B, for not a single leaf of either of the two plants we have has shown the attack of this fungus. Instead, the old leaves have shown a conspicuous yellowing on the under surface. Every now and then also a brown spot or two may be noted on some of the leaves, but the plant does not seem to suffer from these two abnormalities. The cause of the yellowing is at present not known. The brown spotting is due probably to insect bite.

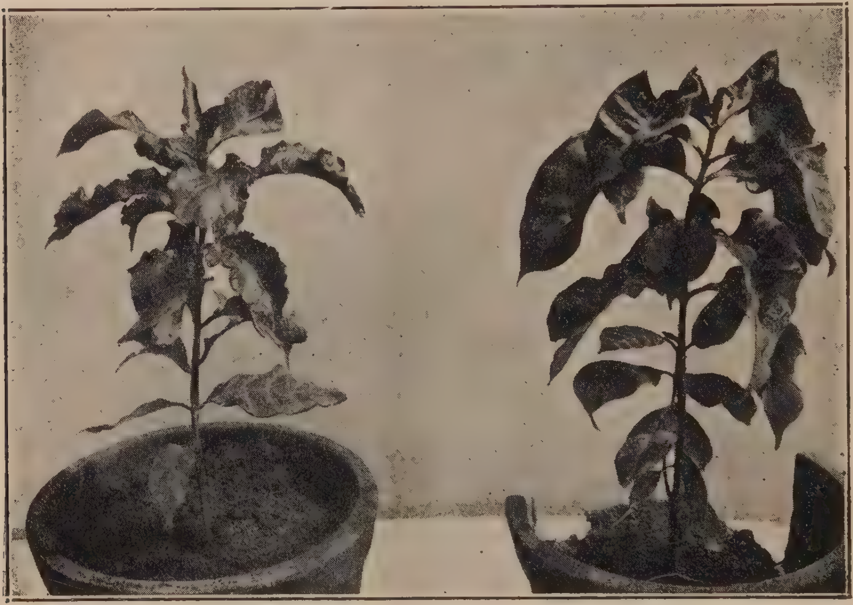

Fig. 5.—Two Kawisari B seedlings showing "curly leaf" abnormality.

The resistance of the Kawisarie B plants may be emphasized when it is pointed out that several plants belonging to different varieties of the Arabica coffee which are growing in the same yard as the Kawisarie plants, despite their comparatively recent arrival here,already have suffered heavy defoliation from an attack of *Hemileia vastatrix*. Figure 4 shows one of these Arabica plants.

Plant No. 1 attacked by stem borer. On March 7, 1931, plant No. 1 was observed to be wilting. Upon examination it was found that a borer had mined the main stem down to a point above the place of union of the stock and scion which was about 20 centimeters from the ground. At this point the borer had almost cut the stem resulting in the partial wilting of the plant. To make use of the portion of the plant above the cut, it was severed and prepared into cuttings for grafting and planting. The borer was subsequently identified by Dr. L. B. Uichanco, of this College, as *Zeuzera coffeæ* Nietn., Cossidae, Lepidoptera.

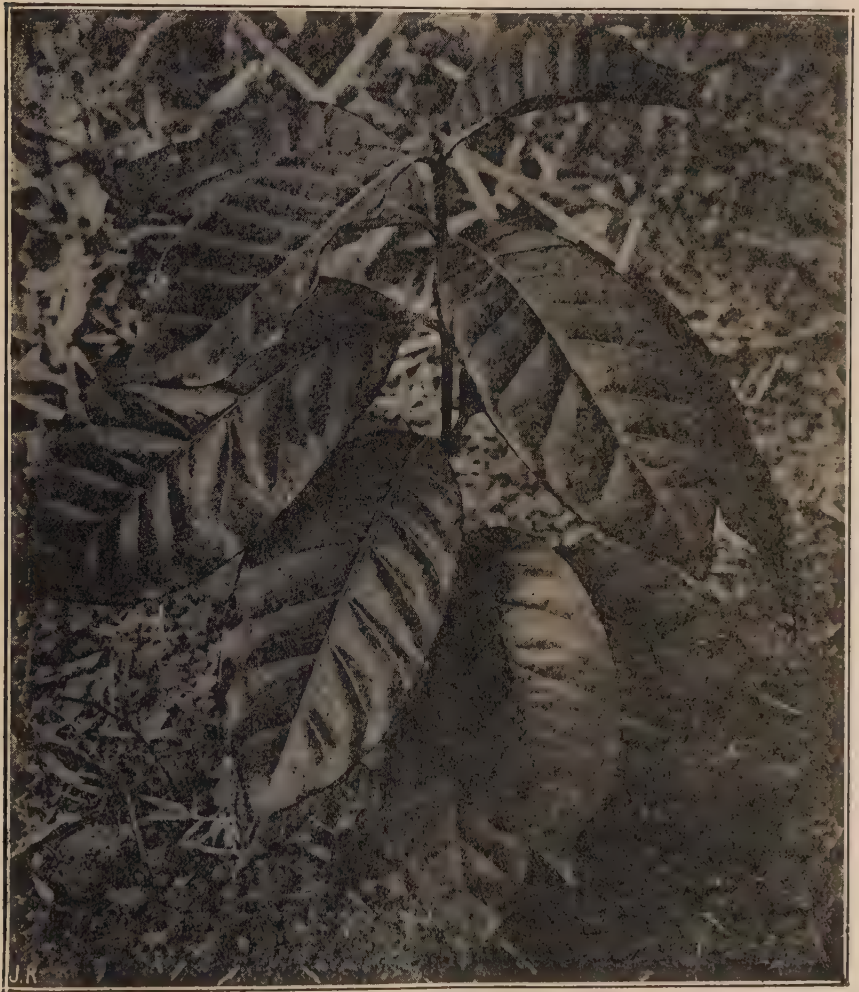

Fig. 6.—A healthy Kawisari B seedling.

Propagation of the plants and study of seedlings. On July 11 and 18, 1929, 18 cuttings were obtained from plant No. 2 and grafted on Excelsa stocks. None of the grafts grew because of the poor condition of the stocks used and the fact that the grafted plants were kept in a very wet place.

The seeds which were harvested from plant No. 1 during the period beginning December 8, 1929 and ending December 26, 1930 were planted for propagation purposes. A germination of 67 per cent was obtained. We now have more than 700 seedlings of Kawisarie B, or enough to plant two-thirds of a hectare. There is only one important point which should be mentioned in connection with these seedlings, and that is that about 15 per cent of them show an abnormality which is not exhibited by seedlings of other varieties raised in the Philippines. This abnormality consists in the curling of most of the leaves of each affected seedling, the curling being accompanied by a sickly appearance of the plant. Figure 5 shows two of these affected plants. This malady which Mr. E. F. Roldan of the Plant Pathology Department believes to be due to mosaic, appears to be characteristic of Kawisari seedlings for upon reviewing thc notes which I made while visiting the Government coffee plantation at Bangelan, Java, I found that I made the same observation on the Kawisari seedlings I saw there. All the seedlings which showed this abnormality were burned except four which were given to Dr. G. O. Ocfemia of the Plant Pathology Department for observation. These four plants seem to increase in height normally but their leaves continue to be curly. The normal seedlings have been set out and they will be the subject of a separate report in the future. Figure 6 shows a normal Kawisarie B seedling as it is now growing in the field.

On March 7, 1931, when plant No. 1 was cut by a borer, 17 cuttings were obtained from the upper portion of the plant and grafted on Robusta stocks in the coffee nursery. One cutting was planted direct in soil in a box to root. Of these cuttings only very few are from vertical growths, most of them being from horizontal branches.

DISCUSSION OF RESULTS

From the results of observation which has so far been made on the two Kawisari B plants under report, it appears that this hybrid is coming true to the reputation it has made in Java, its home country. The plants have grown vigorously and have not shown any sign of attack of the coffee rust (*Hemileia vastatrix*).

Plant No. 1 yielded 36.4 grams of fresh berries the first month it fruited and 1.55 kilograms the first year following. Plant No. 2 yielded 1.905 kilograms during the first nine months of fruiting. These yields are considered quite satisfactory for four-year old plants.

The harvesting period of this hybrid has extended practically throughout the year, thus again showing that it promises to be a constant cropper here as it has been reported to be in Java. The quality ratio found for Kawisari B as well as the relation of volume of fresh berries to weight of market coffee have been satisfactory also.

SUMMARY

As early as 1912 the value of the Liberica-Arabica coffee hybrids of Java had been brought to the attention of the Philippine government and an attempt was made in that year to import them in the form of scions but this attempt failed. In 1917 an important officer of the government who was sent to Java to study the coffee culture in that country stated in his report that it was not necessary then to import these hybrids into the Philippines. Partly for this reason probably, and partly because of the difficulty of importing the hybrids, the Philippines failed to introduce them until August 23, 1927, when the College of Agriculture through a member of the staff, succeeded in bringing into this country two budded plants of one of these hybrids; namely the Kawisari B, which is considered the most valuable of them.

These Kawisari B plants have been grown at an altitude of about 80 meters where they have grown vigorously, without showing any sign of attack of the coffee rust (*Hemileia vastatrix*), and have given a very satisfactory initial yield.

The plants are now being propagated by seed, by grafting, and by cuttings.

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A COMPARATIVE STUDY OF CORN, CASSAVA, SWEET POTATOES AND PONG-APONG AS FEEDS FOR SWINE[1]

MARIANO MONDOÑEDO AND FIDEL ALONTE
Of the Department of Animal Husbandry

This report is a part of a series of studies on carbonaceous or basal feeds for swine. The immediate object of the work is to determine the feeding value of feed stuffs commonly available. The ultimate end in view is to know or determine as large a number as possible of feeds available for hog feeding; and to use them most efficiently and economically.

The substitution of one feed for another is an important and ever present factor in swine feeding. Some feeds become scarce; others become available. Feed prices change from time to time. The hogs pass from one purpose or condition to another. Environmental factors, such as weather conditions, vary. A change in any one or in the combination of these factors calls for variation in the character of the ration if the best results are to be obtained.

No sound and safe change in ration, however, can be made unless the feeding value of local feed stuffs for hogs under our particular conditions is known.

The present work takes up for study cassava, sweet potatoes and *pong-apong*. Corn is taken as the standard feed for comparison. This work consists of two feeding trials of a 70-day period each. The first test started on February 15 and closed on April 26, 1926. The second test started May 14, and closed July 23, 1926. The object of the first trial was to compare the effect of each of these feeds on pigs two and one half months old fed in dry lot for 70 days; the second test had a similar object but pigs 5 months old fed the same length of time were used.

Twenty Berkshire-Native grade pigs purchased in the market of Calamba, Laguna, were used. For the first test, experiment 1, these pigs were divided into four lots making the lots as uniform as possible. At the close of the experiment the pigs were cared for and fed together. They were fed a mixture of the four rations used in experiment 1. Just before the second test was started the same pigs were again divided in lots making the lots as uniform as possible as to type, condition, and weight.

The feeds under study were fed boiled. The other feeds making up the rations were fed in uncooked form, water was added to them immediately before feeding. For each lot of pigs a sufficient amount of the cooked feeds was added to the uncooked feeds to make up the ration called for.

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[1] Experiment Station contribution No. 725. Received for publication February 18, 1931. Read before the Los Baños Biological Club June 25, 1931.

The initial and final weights were taken as usual. Partial weights were taken weekly and in the afternoon before feeding.

NATURE OF THE FEEDS UNDER STUDY

A brief account of the nature of corn and cassava are given in the first report of this series of study.[2]

Sweet potato. Sweet potato (*Ipomoea batatas* Linn.) (Poir) is a field crop that can be grown throughout the year. It is known to thrive well in all parts of the Islands in almost any soil. It does best, however, on light, well drained soil, particularly for the production of tubers. The roots and vines are relished by swine. It is the best pasture crop for hogs so far known in this locality as they relish the roots and vines. It does not cost much to prepare the soil, plant and cultivate sweet potatoes. The vines and the tubers may be available within two to three months after planting, so rapidly does the plant grow. It stands tramping well and the plant recovers quickly if given a rest from the pigs.

Pong-apong. (*Amorphophalus campanulatus* (Roxb.) Blume ex Deene.) *Pong-apong* is a wild plant producing a large root stock. The stem as well as the root stock is utilized for hog feeding in many places in the Islands. It is chopped up and cooked while fresh. If it is to be stored for future use it is either sliced and dried in the sun or the whole root stock is buried in the soil. While its use for hog feeding is a general practice in the Philippines there has been nothing published regarding this use.

Santos and Adriano (1928) give the analysis of sweet potato and *pong-apong* tubers as follows:

NAME	WATER	ETHER EXTRACT	ASH	PROTEIN N x 6.25	CRUDE FIBER	CARBOHYDRATE BY DIFFERENCE	CALORIES PER 100 GRAMS
Camote (sweet potato)........	68.87	.52	1.00	.86	.88	27.87	103.32
Pong-apong......	74.81	.38	.73	5.10	.61	18.37	85.00

For the four lots of pigs the following rations were used:

FEEDS USED	LOT I	LOT II	LOT III	LOT IV
Corn[a]..	25	—	—	—
Cassava..	—	25	—	—
Sweet potato..	—	—	25	—
Pong-apong..	—	—	—	25
Rice bran..	50	50	50	50
Copra meal..	25	25	25	25
Total..	100	100	100	100

[a] For every part of corn used 2 parts of cassava, sweet potato, or pong-apong was used.

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[2] See page 524, THE PHILIPPINE AGRICULTURIST, Vol. XV, No. 9, February, 1927.

One per cent of equal parts of corn-cob charcoal and common salt was added to the ration of each lot.

Price of the feeds used:

Corn	8.00 centavos
Cassava	2.00 centavos
Sweet potato	2.00 centavos
Pong-apong	2.00 centavos
Rice bran	4.50 centavos
Copra meal	5.00 centavos

REVIEW OF PAST LITERATURE

Duggar (1898-9) reported that 190-pound (96.17 kgm.) hogs fed sweet potatoes plus cowpeas made a kilogram gain from 13.34 kgm. ration. A similar lot of pigs fed corn meal plus cowpeas made a kilogram gain from 3.6 kgm. feed.

Mondoñedo and Bayan (1927) in comparing the feeding value of cassava with corn, fed for 70 days a lot of 7 weanling pigs on sweet potato pasture a ration made up of 40 parts corn, 40 parts rice bran, 15 parts copra meal and 5 parts dried shrimps. The pigs made an average daily gain of .214 kgm. and required 2.89 kgm. ration to make a kilogram gain. In another lot where 20 parts of the corn was replaced by 20 parts cassava, the pigs made an average daily gain of .206 kgm. and required only 2.65 kgm. ration for every kilogram gain.

In feeding the same rations to the same pigs in dry lot for the next 70 days the corn lot made an average daily gain of .138 kgm., requiring 6.84 kgm. ration to make a kilogram gain. The cassava lot made an average gain of .175 kgm., requiring 6.52 kgm. ration for every kilogram gain made.

In another set of experiments where 30 parts shelled corn, and 30 parts ground corn were each replaced by 30 parts cassava in conjunction with 50 parts rice bran and 20 parts copra meal and fed to 9 months-old barrows in dry lot, the pigs made an average daily gain of .326 kgm. The ground corn lot gained daily .336 kgm. and the shelled corn lot .327 kgm., the first required 6.46 kgm., the second, 6.30 kgm. and the third, 6.49 kgm. feed to make one kgm. gain.

Mondoñedo (1928) fed a lot of 8 months-old pigs in dry lot a ration of 20 parts corn, 70 parts rice bran, 8 parts copra meal and 2 parts shrimps. Another lot was fed a similar ration except that the corn was replaced by raw chopped cassava. The corn lot made an average daily gain of .364 kgm. and the cassava lot .394 kgm. The corn lot required 4.32 kgm. feed and the cassava lot, 4.76 kgm. to make one kgm. gain.

MANAGEMENT

The experiment was conducted at the Laguna Poultry-Swine breeding station. During the tests each lot of pigs was kept in a one-sixteenth hectare inclosure, practically bare of edible grass.

To house the pigs a temporary 2×2 meter cogon shed open on all sides was made in each lot. Additional protection from the sun was afforded by the growing ipil-ipil posts of the fence around the inclosures.

The pigs had no access to wallows; they were furnished water in troughs at noon. They were fed all they could easily clean up twice daily. The management was far from the ideal method to follow under farm conditions but it was much like the practice followed in feeding and handling fattening pigs in the back yards, with improvement in sanitation.

TABLE 1

Summary of results of the two feeding trials

	EXPERIMENT I (FIRST 70-DAY PERIOD)			
	Lot I (Corn)	Lot II (Cassava)	Lot III (Sweet potato)	Lot IV (Pong-apong)
Date experiment started and closed	February 15 to April 26, 1926			
System of feeding and handling	Hand fed; dry lot			
Number of pigs in experiment	5	5	5	5
Average initial weight	9.98 kgm.	9.96 kgm.	9.92 kgm.	9.88 kgm.
Average final weight	16.40 kgm.	15.34 kgm.	15.24 kgm.	14.58 kgm.
Average gain in weight	6.42 kgm.	5.38 kgm.	5.32 kgm.	4.70 kgm.
Average daily gain per pig	.092 kgm.	.077 kgm.	.076 kgm.	.067 kgm.
Feed consumed per pig	35.60 kgm.	39.17 kgm.	42.73 kgm.	29.60 kgm.
Average ration in kilograms	.51 kgm.	.56 kgm.	.61 kgm.	.42 kgm.
Average ration in percentage	3.9 per cent	4.4 per cent	4.9 per cent	3.5 per cent
Feed required per kgm. gain	5.55 per cent	7.28 per cent	8.03 per cent	6.30 per cent
Cost of feed per kgm. gain	₱.30	₱.33	₱.36	₱.28

	EXPERIMENT II (SECOND 70-DAY PERIOD)			
	Lot I (Corn)	Lot II (Cassava)	Lot III (Sweet potato)	Lot IV (Pong-apong)
Date experiment started and closed	May 14 to July 23, 1926			
System of feeding and handling	Hand fed; dry lot			
Number of pigs in experiment	5	5	5	5
Average initial weight	16.64 kgm.	15.04 kgm.	14.48 kgm.	15.36 kgm.
Average final weight	21.14 kgm.	19.50 kgm.	18.80 kgm.	18.24 kgm.
Average gain in weight	4.50 kgm.	4.46 kgm.	4.32 kgm.	2.88 kgm.
Average daily gain per pig	.064 kgm.	.064 kgm.	.062 kgm.	.041 kgm.
Feed consumed per pig	41.60 kgm.	52.04 kgm.	40.60 kgm.	44.66 kgm.
Average ration in kilograms	.59 kgm.	.77 kgm.	.58 kgm.	.64 kgm.
Average ration in percentage	2.69 per cent	4.5 per cent	3.5 per cent	3.8 per cent
Feed required per kgm. gain	9.24 per cent	11.74 per cent	9.40 per cent	15.51 per cent
Cost of feed per kgm. gain	₱.51	₱.53	₱.42	₱.70

	EXPERIMENT I AND II (TOTAL 140-DAY PERIOD)			
	Lot I (Corn)	Lot II (Cassava)	Lot III (Sweet potato)	Lot IV (Pong-apong)
Date experiment started and closed	February 15 to July 23, 1926			
System of feeding and handling	Hand fed; dry lot			
Number of pigs in experiment	5	5	5	5
Average initial weight	9.98 kgm.	9.96 kgm.	9.92 kgm.	9.88 kgm.
Average final weight	21.14 kgm.	19.50 kgm.	18.80 kgm.	18.24 kgm.
Average gain in weight	11.16 kgm.	9.54 kgm.	8.88 kgm.	8.36 kgm.
Average daily gain per pig	.080 kgm.	.068 kgm.	.063 kgm.	.060 kgm.
Feed consumed per pig	77.20 kgm.	91.21 kgm.	83.32 kgm.	74.26 kgm.
Average ration in kilograms	.55 kgm.	.65 kgm.	.60 kgm.	.53 kgm.
Average ration in percentage	3.5 per cent	4.4 per cent	4.1 per cent	3.8 per cent
Feed required per kgm. gain	6.92 per cent	9.56 per cent	9.38 per cent	8.88 per cent
Cost of feed per kgm. gain	₱.38	₱.43	₱.42	₱.40

RESULTS AND DISCUSSIONS

Table 1 gives the summary of results obtained from the two feeding periods separately and combined. As criteria or measures of the results obtained, the rate of gains, feed required to make a given unit of gains and the cost per unit of gains were taken.

Experiment I (first 70-day period)

1. Taking the corn lot as the basis for comparison; this lot made the most rapid rate of gain, cassava and sweet potato, second, and *pong-apong* third. (See table 1). Expressing the difference in results obtained on the percentage basis, if the corn lot is 100 per cent, the cassava and sweet potato lots were 84 per cent, and *pong-apong* only 74 per cent.

2. As to the amount of feed required to make one kgm. gain, the corn lot was decidedly superior requiring only about 5.5 kgm. feed; the *pong-apong* lot second, with 6.3 kgm.; and the cassava, third with 7.3 kgm. and the sweet potato fourth, with 8.0 kgm. The difference between the feeds in the order given above is 100, 113, 131 and 145 per cent ration required by the respective lots to make one kgm. gain. These figures for the roots are on the basis as fed; that is, 2 kgm. of roots as the equivalent to 1 kgm. corn.

3. From the basis of cost of feeds per kgm. gain made, *pong-apong* lot cost 28 centavos, corn lot, 30 centavos, cassava lot, 33 centavos, and sweet potatoes, 36 centavos. In other words in the *pong-apong* lot, it cost 6 per cent less, in the cassava lot, 8 per cent more and in the sweet potato lot 19 per cent more than in the corn lot to produce one kgm. gain.

In general, the results, particularly with regard to rate of gains, are not as good as were obtained from other feeding trials, as may be noted from the results obtained by Mondoñedo, and Mondoñedo and Bayan in their tests on corn and cassava. These poorer rates of gain may be due largely to the fact that the rations used were deficient both in the quality and quantity of protein supplement. The housing and watering facilities were very limited because of circumstances, and also the pigs were dry lot fed.

The corn, cassava, and sweet potato rations were very much relished by the pigs. The pigs on the sweet potato ration, when through oversight some scabby potatoes were included, refused to eat all or part of the ration even though they were still not fully satisfied.

The *pong-apong* lot made the poorest showing as to rate of gains and palatability of the ration. However, it was almost as good as the corn lot as to the amount of concentrates required for one kgm. gain, and was the lowest in feed cost. Even after it was cooked, *pong-apong* was still irritating (itchy) as evidenced by the fact that for several weeks the pigs would eat only a little at a time, and would leave the trough and rub their snouts against objects. They got over this, however, before the experiment was closed.

Experiment II (second 70-day period)

1. The corn, cassava and sweet potato lots made about the same rate of gains in weight—all three averaged .06 kgm. daily, with the *pong-apong* lot making only .04 kgm.

2. The corn and sweet potato lots each required about 9 kgm. feed, cassava lot 12 kgm. and *pong-apong* lot, 15.5 kgm. to make one kgm. gain each.

3. It cost 42 centavos for the sweet potato lot, 15 centavos for the corn lot, 53 centavos for the cassava lot, and 70 centavos for the *pong-apong* lot each to produce one kgm. gain.

The outstanding result obtained in this trial is that cassava and sweet potato in rate of gain proved to be as efficient as corn. In the first trial they were only 84 per cent as efficient as corn. This result seems to indicate that the feeding value of these roots increases as the pigs grow older, particularly when dry lot fed. This result corroborates the finding of Bolivar (1928) who concluded that for older pigs in dry lot roots give better results than corn. Not only do they furnish the necessary carbohydrates but also bulk and succulence.

All the lots did not make as rapid gains as they did in the first period. Inasmuch as they were given the same care, feeding and handling in both periods the factors that had varied were the weather condition, that of dry to wet weather, and the age of the animals. The hogs being more or less in the open, they were exposed to extreme variation of temperature during the second period.

SUMMARY OF EXPERIMENTS I AND II

(*140-day feeding test*)

1. From the point of view of rate of gains made the cassava and sweet potato lots averaged 87 per cent as efficient as corn, and the *pong-apong* lot, 75 per cent.

2. The corn lot required 6.92 kgm., the cassava lot, 9.56 kgm., the sweet potato lot, 9.38 kgm., and *pong-apong* lot, 8.88 kgm. rations to produce one kgm. gain in weight.

3. Based on feed cost of one kgm. gain, the corn lot was first with 38 centavos, the *pong-apong* lot, second with 40 centavos, and the sweet potato and cassava lots, third with about 43 centavos each.

The result that comes into prominence in combining the two periods of study into one period of 140 days is the ability of the *pong-apong* ration to maintain almost as good a rate of gain as the cassava and corn rations, and with a comparatively smaller amount of feed and at a less cost. This result explains why *pong-apong*, in spite of its unpalatability, is in general use by the small farmers for feeding their hogs.

SUMMARY OF CONCLUSIONS

1. Cassava or sweet potato is a good substitute for corn in the ration of pigs above 5 months old when fed in dry lot.

2. Two parts by weight of cassava or sweet potato are about 87 per cent as one part corn in feeding value, and two parts of *pong-apong* are equivalent to 75 per cent. In other words, 2.3 parts cassava or sweet potato and 2.67 parts of *pong-apong* are equivalent to 1 part corn.

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COMPARATIVE DEVELOPMENT OF ROOTS OF RICE PLANTS GROWN IN POTS CONTAINING AMMONIUM SULFATE FERTILIZER OF DIFFERENT AMOUNTS[1]

PABLO P. LIBATIQUE

WITH ONE PLATE AND TWO TEXT FIGURES

Although frequently neglected and probably at times even considered rather insignificant, the roots of plants, such as the rice plant, are just as important for its welfare and development as are the tops. The explanation of the peculiar development that the rice plant always attains when liberally supplied with ammonium sulfate fertilizer might be found in the stunted development of the root system of the plant. Similarly, the marked delay in fruiting brought about by a liberal application of ammonium sulfate might find its initial or primary cause in the stunted and poor development of the root system of the plant. It was with these objectives in mind that the present study was undertaken.

The writer found no literature on the influence of fertilizers on the development and the anatomy of the root of the rice plant. Studies have been made on the root systems without reference to fertilization. David (1925) reported that the root systems of different varieties of rice were of different sizes, or different degrees of development. He found also that the amount of water in the soil influenced favorably the growth and development of the roots of the rice plant, and that the weight of the roots was proportional to the size of the shoot.

Weaver (1926), found that the young portions of the roots of many species of plants were the most efficient in the absorption of nutrients. In his studies on the influence of fertilizers on root development, Weaver reports that the roots that came in contact with a fertilizer layer developed abundantly and branched profusely, but that the vertical penetration of these roots into the soil was retarded. From this observation, he concluded that fertilizing the surface layers of soil in regions where there is very little water is detrimental to normal crop production.

The study reported in this paper was conducted in the Department of Plant Physiology, College of Agriculture, University of the Philippines, Los Baños, Laguna, from April, 1929 to January, 1930.

It was carried out with the object of determining: (*a*) the relative sizes of the root systems of the rice plants at different ages; (*b*) the influence of the different amounts of ammonium sulfate fertilizer used on the development of the root system; and (*c*) the effect of the fertilizer upon the anatomical structures of the roots of the plant.

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MATERIALS AND METHODS

The plant

Seeds of lowland rice (Ramai variety) obtained from the Department of Agronomy, College of Agriculture, were used in this study. Four seeds were planted in each pot. Upon germinating, two seedlings apparently of uniform development were selected and left in the pot, and the other two were discarded. Then the fertilizer was added to the soil in the pot.

Culture media

The soil used. Forty-eight empty kerosene cans were used as pots and were filled with ordinary garden clay-loam soil. The soil was thoroughly pulverized and roots of weeds and other solids usually found mixed with it were removed. Each pot had a surface area of about 625 square centimeters and contained about 18,750 cubic centimeters of soil.

Fertilizer used. Ammonium sulfate fertilizer furnished by the Department of Plant Physiology, containing 19.57[3] per cent nitrogen was used in this study. This fertilizer was used in five different amounts, which were added to cultures II, III, IV, V and VI. Eight replications of each culture were made. Culture I, received no fertilizer and was used as the control.

The fertilizer was applied seven days after the seeds had been sown in the pots,—when the plants were about four centimeters high. Soon after the application of the fertilizer, the plants were treated as lowland rice by over-saturating the soil with water. Throughout the course of the experiment water was kept about two to five centimeters above the surface of the soil in each pot.

Sets of cultures. Forty-eight pots were used in each set of cultures. The cultures were arranged in six rows, eight cultures in each row. The first row was designated as culture I and received no fertilizer. The next row, culture II received 2.72 grams of ammonium sulfate. The third row, culture III received 5.43 grams of the fertilizer. Culture IV had received 10.87 grams; culture V, 21.74 grams; and the last row, culture VI, 43.48 grams of the fertilizer.

A similar procedure was followed with the second set of cultures, with slight changes in the amounts of the fertilizer used. Culture II of the second set received 3.35 grams; culture III, 6.35 grams; culture IV, 13.91 grams; culture V, 23.48 grams; and culture VI, 43.48 grams, the same amount as in the first set.

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[3] Analyzed by the Department of Chemistry of the College of Agriculture.

Care of cultures. After planting the seeds in the pots, care was taken to keep the cultures free from weeds; and the plants were placed in such a way that they were fairly equally exposed to sunshine and air. The cultures were kept free from the attack of injurious insects and supplied with water whenever needed.

Methods of study

Fifteen days after planting, the first harvest was made. The appearance of the plants was noted. Then the soil in one pot from each type of culture was washed away carefully and all the roots were gathered, washed, and examined carefully. The culms and the leaves were also gathered.

A similar procedure was followed in harvesting the other cultures. Some were harvested at the age of 30 days; others at 45 days, 60 days, 75 days, and 90 days. The last harvest was made when the plants were 90 days old. The plants were brought to a laboratory room and the roots, culms, and leaves were separately counted and measured. Then after being properly labeled, these materials were first dried in the sun, then the final drying to constant weight was done in a Freas electric oven. After they were dried thoroughly, the roots, culms, and leaves were weighed separately on a sensitive balance and the data obtained from the 15-day, 30-day, 45-day, 60-day, 75-day and the 90-day cultures were separately recorded.

Anatomy of the roots

Two rows, (or six duplicate pots) of the 90-day old cultures that received different amounts of the ammonium sulfate fertilizer (and one duplicate culture without fertilizer) were used for the microscopic study of the roots. Roots were taken from each culture and the soil particles clinging on them were washed away carefully. Cross sections of some of the roots were prepared and the sections were permanently mounted on glass slides with Canada balsam (without fixing and staining the sections), as directed by Chamberlain (1905). Under the microscope, careful examination of the internal structures of the roots produced by the plants grown in the different cultures was made, and camera lucida drawings of these structures were made.

EXPERIMENTS AND RESULTS

Experimental cultures made

Two sets of culture were conducted. The first set was planted on April 25, 1929, and the cultures were harvested at the end of every 15 days so that the last harvest was made on July 24, 1929, when the plants were 90 days of age. The second set was planted on August 22, 1929 and the cultures were also harvested at the end of every 15 days. Thus, the harvest of the 90-day old plants was made on November 20, 1929.

Criteria of results

External appearance of plants. From time to time the plants in the different cultures were observed and any change in appearance was noted. However, most of the notes under this criterion were obtained at the time of harvest of the plants of different ages when the roots were visible. The notes were briefly recorded in tables 1[3] and 3 for the first set of cultures, and in tables 2[3] and 4 for the second set. To show the relative development of the roots of the plants that received different amounts of fertilizer, the harvests made when the plants were 75 days of age were photographed, (see fig. 1 and 2).

Number of roots. The data on the number of roots were obtained after thoroughly cleaning the roots of soil particles. Only the principal roots were counted and the data obtained for the first set of cultures are shown in tables 1[3], 3, and 5, and those for the second set of cultures in tables 2[3], 4, and 6.

Total length of the roots. The data under this criterion were obtained as follows: The roots were detached from the plant at their points of connection to the basal end of the culms. The principal roots were placed end to end on a table. For convenience of measurement several rows of roots were placed end to end and measured with a meter stick. The total length of the roots of each plant was later determined. The original data thus obtained are recorded in tables 1 and 2 (see footnote 3). The data as relative values for the first set of cultures are shown in tables 3 and 5; those from the second set of culture are shown in tables 4 and 6.

Total diameter of roots. After obtaining the total length, the roots were placed side by side as close as possible on a table, and the total diameter was measured. The original data under this criterion obtained from the first set of cultures are given in table 1; those from the second set of cultures, in table 2 (see footnote 3). The data under this criterion were reduced to relative values, (see tables 3 to 6).

Dry weight of roots. After taking the measurements of the roots, they were wrapped in paper and dried in the sun, then given a final drying in an electric oven. When thoroughly dry, they were weighed and the data obtained recorded in tables 1 to 6. (Tables 1 and 2 not published.)

Criteria of results other than on roots

In order that, at least, a brief study might be made on the relative development of the top and of the root of the same plant, data other than on roots were also gathered.

Number of culms. At the time of each harvest, the culms on each plant were counted, and the original data obtained recorded in tables 1 and 2, (see footnote 3) but the data, as relative values, are given in tables 3 to 6.

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[3] Owing to lack of space tables 1 and 2 are not published; they are filed with the Department of Plant Physiology, College of Agriculture.

Number of leaves. Also, at the time when each harvest was being made, the leaves were counted. The data obtained were recorded in tables 1 to 6.

Dry weight of tops. After counting the culms and the leaves from each plant, these were wrapped in a piece of paper and dried in the sun, then finally dried in an electric oven. After drying, they were weighed. The data obtained under this criterion were recorded in tables 1 to 6.

DISCUSSION OF RESULTS

External appearance of plants

In both sets of cultures, it was noticed that at the age of 15 days the plants that received the different amounts of fertilizer were about equally developed. However, the control plants, that is, those that did not receive fertilizer, had paler leaves even at this age than the fertilized plants. In height, both the fertilized and the unfertilized plants were apparently the same.

By the second harvest, when the plants were 30 days of age, marked differences were noticed between the fertilized plants and the control plants. The fertilized plants were decidedly darker green in color and taller than the control plants. Among the fertilized plants, marked differences in development of top were quite apparent even at this age of the plants. The intensity of greening of the leaves appeared directly proportional to the amount of ammonium sulfate fertilizer applied. Abnormally dark green leaves were produced by the plants that were supplied with the largest amount of the fertilizer. Also, the most heavily fertilized plants were the tallest, and the least fertilized, the shortest. The fertilized plants remained markedly different in development, at least so far as the tops were concerned, throughout the experimental period, that is, until the plants attained the age of 90 days. The relative development of the rice plants in a set of cultures at the age of 75 days is well shown in figures 1 and 2. The control cultures had plants that remained the shortest and the palest throughout the experiment. The development of the tops of the rice plants in the fertilized cultures was proportional to the amount of the fertilizer applied.

As to the root development, it appears that the roots of the fertilized cultures were more numerous but shorter than the roots of the control cultures. This condition became more strikingly apparent as the plants grew older. The control, or unfertilized plants had few but long roots.

Among the fertilized cultures, the root system of culture VI, which received the largest amount of ammonium sulfate fertilizer, (see fig. 2) was throughout the experiment smaller and shorter than any of the other cultures. Cultures III, IV and V had rather bulky root systems. On the whole, ammonium sulfate fertilizer, although it tends to promote root development of the rice plant when used in moderate amounts, in large amounts, tends to retard the development of this organ, not only in number of roots but also in length. As shown in figure 2 and as was noted during the course of this study, the development of the roots of the fertilized cultures appeared to be almost inversely proportional to the development of the tops. In other words, the heavy development of top was not always accompanied by a corresponding heavy production of roots. But as the development of top became more profuse as influenced by an increase in the application of the fertilizer, it was accompanied by an increase in intensity of the greening of the leaves, and apparently was accompanied by a poor root development.

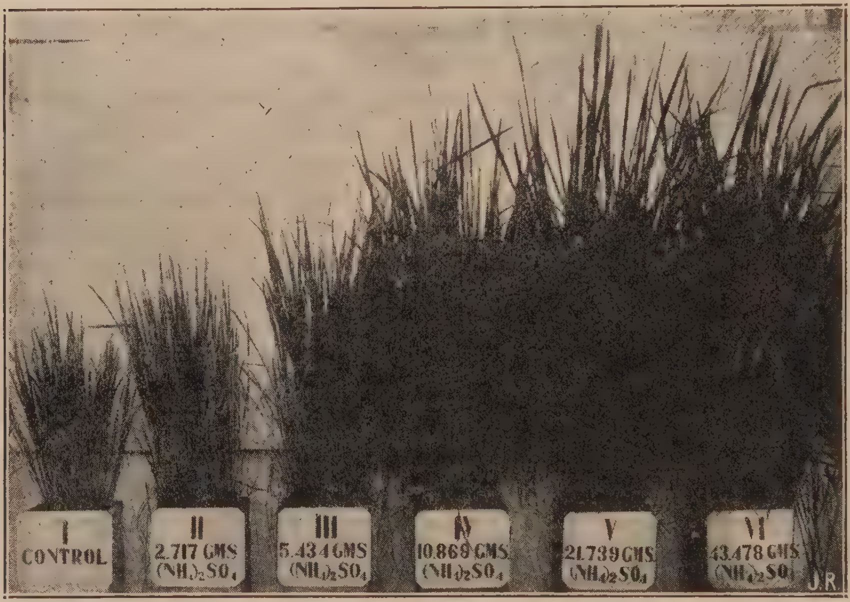

Fig. 1.—Showing the relative development of the plants at the age of 75 days—as influenced by the amounts of ammonium sulfate fertilizer used. As the amount of the fertilizer was increased there was a corresponding increase of the size of top, and the leaves became dark green.

Development of roots as influenced by the amount of ammonium sulfate used

Number of roots. As shown in tables 3 and 4, the number of "principal" roots was materially increased by the application of ammonium sulfate fertilizer. Indeed, irrespective of the age of the plant, the control cultures always had the fewest roots, except in one instance, when the plants in the second set of cultures were 15 days old. However, this criterion does not include the branch roots, although from the standpoint of absorption of soil water these are probably just as efficient, or even more so, as the "principal" roots. The reason for the omission was the difficulty in counting the very numerous branch roots, their branches, and sub-branches.

Data in tables 3 and 4 also show that among the fertilized cultures, those that received the smallest amount of ammonium sulfate (2.72 and 3.75 grams) had the most "principal" roots when the plants were 15 days old. But, as the plants grew older, the cultures that received the larger dose of ammonium sulfate produced the more roots. This finding seems to indicate that the production of the "principal" roots favorably accompanied both the advance in age of the plant and the increase in application of the fertilizer.

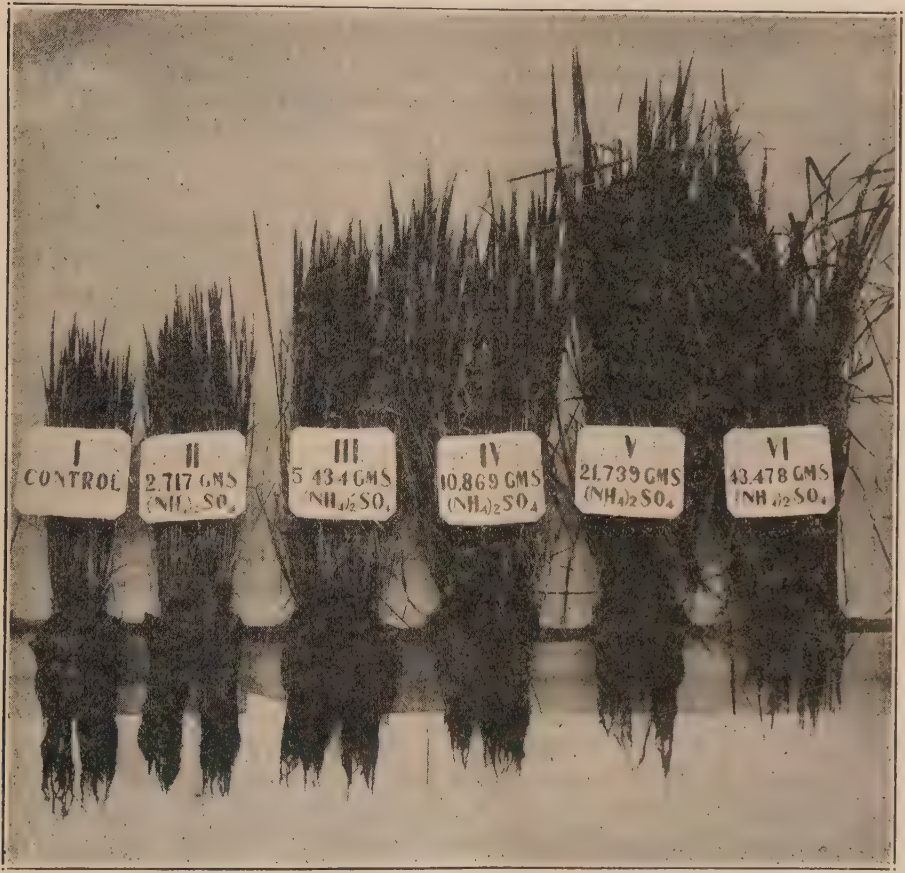

Fig. 2.—Showing the relative sizes of the root systems and of tops of the plants at the age of 75 days—as influenced by the amounts of ammonium sulfate fertilizer used. Heavy applications of the fertilizer in each case resulted in a decrease of root system. The roots became shorter.

Total length, total diameter, or dry weight of roots. Owing to divergence of figures, or data obtained under each of these three criteria, (see tables 3 and 4), only a brief study was made of these data. The data on hand seem to show that even under the same age of the rice plants, the yields of roots, under any of these three criteria here used, were not directly or proportionately influenced by the rates of application of the fertilizer.

Development of roots as influenced by the age of the plants

Number of roots. As shown in tables 5 and 6, the formation of "principal" roots was materially and invariably influenced by the age of the rice plants. This condition was found true in the unfertilized as well as in the fertilized cultures. As the plant grew older, (at least up to 90 days, the time when all the cultures were harvested), there was an increase in the number of roots, a condition which, of course, was to be expected. The exact proportion, however, of root formation as influenced by the age of the plant was not known. Data are here presented to supply this deficiency of knowledge on root production.

Examination of the data on hand on the number of roots, (see tables 5 and 6) will show that the proportion of the rate of the formation of the principal roots in all the cultures that received similar cultural treatment (irrespective of the age of the plants) was more or less constant. This proportion appears to be the same in all the sets of cultures that received different amounts of the fertilizer. For this reason, it was found possible to extract averages. The averages, as relative values, of root production according to the age of the plants grown in the first set of cultures (table 5) are 4 per cent for 15-day old plants; 25 per cent for 30-day; 47 per cent for 45-day; 69 per cent for 50-day; 84 per cent for 75-day, and 100 per cent for plants 90 days old. From the second set of cultures (table 6) the results were 3.5, 18.7, 32, 55, 76, and 100 per cent for the 15-, 30-, 45-, 60-, 75-, and the 90-day old plants, respectively. Averaging these two sets we have 4, 22, 40, 62, 80 and 100 per cent for the 15-, 30-, 45-, 60-, 75-, and the 90-day old rice plants. Thus, it appears that if the 90-day old plants produced the normal maximum number of principal roots, and this number may be taken arbitrarily as 100 per cent perfect, therefore, 15-day old plants produced roots only 4 per cent of the normal maximum number; the 30-day old plants, only 22 per cent perfect; the 45-day old plant, only 40 per cent perfect; the 60-day old plants, 62 per cent, and the 75-day old plants, 80 per cent. It appears further that starting from rice plants 15 days of age, the increase in the number of principal roots occurred at the rate of 20 per cent every 15 days of growth of the plant.

Total length and total diameter of roots. Under these criteria, the yields of roots of the rice plants were also proportional to the age of the plants. This generalization holds good in the unfertilized, or control cultures as well as in the fertilized cultures, (see tables 5 and 6).

Dry weights of roots. Examination of the data under this criterion in tables 5 and 6 will show that the dry weights of the roots of the rice plants of different ages that received similar cultural treatment were different. As was to be expected, the oldest plants had the heaviest root yield and the youngest plants, the lowest. The yield of roots appears to be proportional to the age of the plants. These characteristic proportional yields were obtained from the unfertilized cultures as well as from the cultures supplied with ammonium sulfate. Thus, it appears that the data under this criterion shown in tables 5 and 6 could be averaged, if they are to be grouped according to the age of the plants. Accordingly, the data were averaged and the results are as follows: The 90-day old plants had an average root yield arbitrarily considered as 100 per cent. This being the maximum amount, it could be considered, for the sake of comparison, as 100 per cent perfect in development. The root yields, (in terms of dry weight) of any of the younger plants included in this study may be considered as imperfect. The degree of development towards perfection was only 78 per cent for the 75-day old plants; 40 per cent for the 60-day old plants and 13 per cent for the 45-day old plants. The 30-day old plants had 2.5 per cent, and the plants 15 days old had a root system only 0.11 per cent developed.

As to the highest root yields under each of the criteria on roots here employed, and under each of the cultural treatments given the plants, one may see in tables 5 and 6, that the highest data were obtained always from the 90-day old plants. For convenience in study, the data on *actual values* on roots shown in tables 5 and 6 were transferred to table 7. The highest *actual value* under each criterion in table 7 was arbitrarily considered as 100; the other *actual values* under the same criterion were converted into the corresponding *relative values.*

The data in table 7 show that under the criteria on (*a*) number of roots, (*b*) total length of roots, and (*c*) total diameter of roots, cultures IV and V appear to be the best, as shown by the high *relative values* of the data obtained under these three criteria. However, in terms of the *dry weight of roots,* (which as it includes all the roots, is probably a better criterion to use than any of the three other criteria mentioned above), the best results were obtained from cultures III and IV. Therefore, it would seem safe to assert that the optimal amounts of ammonium sulfate to use for the rice plants to be brought to maturity range from 5.43 to 13.91 grams, or from 1.06 to 2.7 grams of nitrogen per 18.75 cubic centimeters of soil or with a surface area of 625 square centimeters.

The data in table 7 further show that in the case of 90-day old plants, (or mature rice plants) and under the criterion of *dry weight of roots,* it is very evident that the use of ammonium sulfate for rice plants materially influenced the root production of these plants in one way or another. The control plants in the two sets of cultures had an average root development of about 47 per cent; while the fertilized cultures that received the largest amount of the fertilizer tested, (43.48 grams of ammonium sulfate, or 8.51 grams of nitrogen) has an average root developmnt of about 62 per cent as compared with the 100 per cent root development arbitrarily allotted to the cultures that received the optimum rate of application of the fertilizer. Thus, it appears evident that while a moderate use of ammonium sulfate induced, favorably, root growth and development of the rice plants when grown under the conditions of the experiments, a much more liberal application of the fertilizer retarded the formation and development of this organ.

Comparing root yields with top yields of rice plants supplied with ammonium sulfate

The data in tables 3 and 4 show that the formation and development of culms and of leaves were materially and favorably influenced by the application of ammonium sulfate. The data further show that in the two sets of cultures tested, the control, or the unfertilized plants, always had lower yields of culms and of leaves than any of the fertilized cultures. Irrespective of the age of the plants, there was a slight tendency to increase the production of these structures as the amount of the fertilizer was increased.

In terms of the dry weight of tops, data in tables 3 and 4 also show that the application of ammonium sulfate to the culture medium was always accompanied by an increase in dry weight of tops. In almost all the cases here tried, the dry weights of tops of the control cultures were smaller than those from the fertilized cultures. This finding seems to indicate that top production could be favorably induced by the use of the fertilizer.

Both the top yield and the root yield from the same plant were increased by the application of the fertilizer, but the rates of development of the two were not always exactly proportional. As may be seen in the data in tables 3 and 4, sometimes the increase of top as influenced by the fertilizer was much greater than the increase of roots. The converse was also observed to be true. And, in the case of the 75-day and the 90-day old plants, the increase yield of top was not accompanied by a corresponding increase in yield of roots when the plants were supplied with a larger dose of the fertilizer, especially at the rate of 43.48 grams of ammonium sulfate, or 8.51 grams of nitrogen per pot. In other words, while a heavy application of the fertilizer still seemed to favor top development, the root development was seriously checked.

Comparing root and top yield as influenced by age of plants

As shown in tables 5 and 6, there seems to be a correlation between the age of the plant and its yield of top. As the plant advanced in age there was a proportional increase in the number of culms, in the number of leaves, and in the dry weight of top. This correlation was observed both in the unfertilized cultures and in the cultures that received the fertilizer. The proportional increase in the yield of top referred to above was fairly constant in all the culture sets; namely, cultures I to VI. The 15-day old plant under the three criteria, as shown in tables 5 and 6, always produced about 3.5 per cent of top, and as the age of the plant was advanced, there was by 15 days intervals, a corresponding approximately 20 per cent increase yield of top as high as 100 per cent.

Now comparing top yield with the root yield from plants obtained from the same culture, it may be recalled from previous discussions that under any of the culture groups designated as culture I to VI in tables 5 and 6, the advance in age of the plant was always accompanied by an increase in the yield of roots under any of the criteria on roots shown in tables 5 and 6. It has been discussed in the preceding paragraph that the yield of roots was proportional to the age of the plant. Therefore, the production and development of roots of one plant was proportional to the production and development of top of the same plant. This generalization holds good in all the cultures reported in table 1 (see footnote 3) and subsequently presented as a summary of averages in tables 3 to 6, except for a few minor discrepancies and the 75-day and the 90-day old cultures, especially the latter culture which received the highest application of the fertilizer, 43.48 grams of ammonium sulfate or 8.51 grams of nitrogen. These two cultures produced very heavy top yield with rather short roots.

Anatomy of the roots

Examination of cross sections of some representative principal roots taken from each culture was made with the object of finding out if the different rates of application of the fertilizer would affect the development of the internal structures of the roots. Young and old portions of roots were examined. It was found that the different cultural treatments given to the plants were apparently not sufficient to produce marked differences in the root structures of the plants. Also, as shown in plate 1, figures 1-6, no material differences are seen in the internal structures of the roots of the plants that received the six different cultural treatments.

SUMMARY AND CONCLUSIONS

1. Ammonium sulfate fertilizer when used in moderate amounts, tends to promote growth and development of the roots of rice plants. When used in larger amounts, it tends to retard root development, especially in mature plants.

2. The rice plants supplied with ammonium sulfate produced more but shorter roots than the unfertilized plants. The roots of the latter were relatively few but characteristically long.

3. The production of "principal" roots increased with the age of the plant and with the rate of application of the fertilizer. Starting with rice

plants 15 days old, the increase of "principal" roots occurred at the rate of 20 per cent for every 15 days growth of the plant.

4. Arbitrarily considering the root system of the 90-day old plants as perfectly developed, or 100 per cent, the root system of 15-day old plants would be 4 per cent developed; that of the 30-day old plants, 22 per cent; that of the 45-day old plants, 40 per cent; that of the 60-day old plants, 62 per cent; and that of the 75-day old plants, 80 per cent.

5. The optimal amounts of ammonium sulfate for rice plants grown to maturity ranged from 5.43 to 13.91 grams per 625 square centimeters of soil surface.

6. If the root yield from the optimum application of the fertilizer be arbitrarily taken as 100 per cent, the root yield from the control plant would be 47 per cent, and that from cultures with an excess supply of ammonium sulfate, 62 per cent.

7. When supplied with ammonium sulfate in relatively large amounts, the yield of roots from one culture was proportional to the yield of top from the same culture, except in mature plants (75–day and 90–day old).

8. At 15 days of age, the fertilized and the unfertilized plants were apparently similarly developed. The control plants, however, had pale green leaves. At 30 days of age, the different fertilized cultures began to show differences among themselves, in the development of tops.

9. As the rice plants grew older, the yield of top increased with the age of the plant. This condition was not always true in the case of roots; at the age of 90 days, the plants that were supplied with 43.48 grams of the fertilizer produced relatively large tops and strikingly small root systems.

10. Increase in the application of the fertilizer was always accompanied by a corresponding increase in the yield of top and in intensity of greening of leaves. The latter condition was always accompanied by a poor root development.

11. The different treatments given to the rice plants in this study did not produce any apparent change in the anatomical structures of the roots of the plants.

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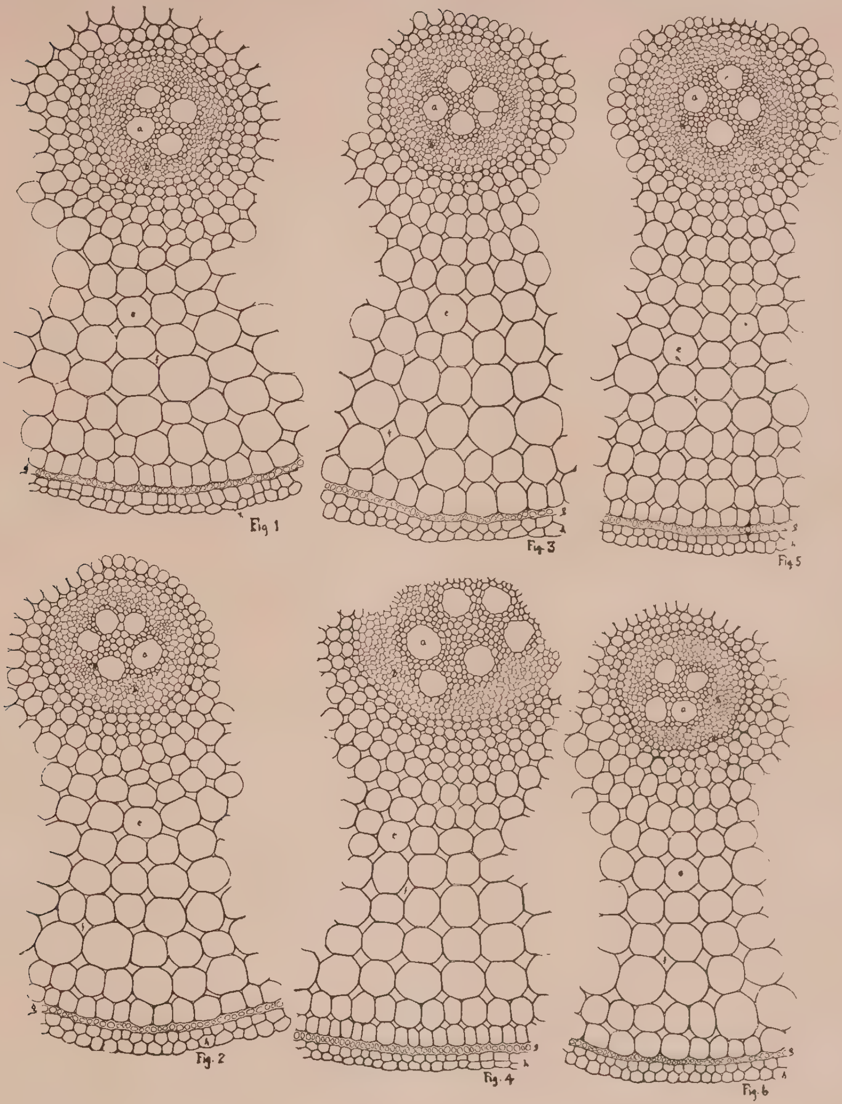
Fig 1
Fig 3
Fig 5
Fig. 2
Fig. 4
Fig. 6

Plate 1

Showing the drawings of the cross sections of the young portions of the roots of rice taken from plants that had different treatments.

TABLE 3

Data as relative values[a] *showing the relative development of the roots and tops of the rice plants that received ammonium sulfate fertilizer of different amounts*
(Compiled from the data recorded in table 1)

AGE OF PLANTS AT HARVEST	TREATMENTS GIVEN	ROOTS				TOPS			EXTERNAL APPEARANCE OF PLANTS
		Number	Total length	Total diameter	Dry weight	Number of culms	Number of leaves	Dry weight	
15 days	No fertilizer (control)	63	68	33	57	33	25	22	Roots whitish brown, few branches; plants normally developed and green.
	2.72 grams ammonium sulfate	100 (22.5)	86	99	59	100	80	80	Roots brownish, abundant branches; plants very good growth, leaves dark green.
	5.43 grams ammonium sulfate	86	96	100 (1.7 cm.)	100 (0.04 g.)	100	85	85	Roots brownish white, abundant branches; plants vigorous, leaves dark green.
	10.86 grams ammonium sulfate	86	83	99	71	83	80	79	Roots brownish white, abundant branches; plants vigorous, leaves dark green.
	21.74 grams ammonium sulfate	98	100 (1.85 m.)	97	91	100	100 (10.0)	100 (0.154)	Roots brownish white, many branches; plants good growth with green leaves.
	43.48 grams ammonium sulfate	67	48	73	60	83	75	62	Roots brownish white; plants with good growth.
30 days	No fertilizer (control)	51	56	54	48	31	32	25	Roots whitish brown, few long; leaves pale green but plants normally developed.
	2.72 grams ammonium sulfate	100 (149.0)	100 (22.62 m.)	100 (16.0 cm.)	100 (1.04 g.)	77	80	75	Roots brownish, many branches; vigorous plants, leaves dark green.
	5.43 grams ammonium sulfate	92	84	82	81	81	80	61	Roots? abundant branches; plants good growth, leaves dark green.
	10.86 grams ammonium sulfate	88	90	90	94	100 (26)	96	91	Roots brownish white, abundant branches; plants vigorous, leaves dark green.
	21.74 grams ammonium sulfate	91	75	88	83	100 (26)	100 (87.0)	100 (5.15 g.)	Roots brownish white, many branches; plants good growth with dark green leaves.
	43.48 grams ammonium sulfate	79	57	68	58	88	82	68	Roots brownish white, many branches; plants vigorous, dark green leaves.
45 days	No fertilizer (control)	51	63	64	55	35	32	16	Roots whitish brown, few branches; plants pale green, stunted in growth.
	2.72 grams ammonium sulfate	74	100 (66.85 m.)	87	100 (4.4 g.)	53	52	45	Roots whitish brown, many branches; plants fair in growth but light pale.
	5.43 grams ammonium sulfate	96	80	95	83	84	75	55	Roots brown color, many branches; plants fair growth, green leaves.
	10.86 grams ammonium sulfate	100 (283.0)	88	100 (24.9 cm.)	90	100 (40)	100 (192.0)	100 (32.71 g.)	Roots brown color, many branches; plants fair growth, green leaves.
	21.74 grams ammonium sulfate	74	72	74	70	95	93	80	Roots brown, abundant branches; small size; plants dark green, good growth.
	43.48 grams ammonium sulfate	60	42	63	51	90	85	62	Roots brownish white; many branches; plants vigorous, dark green leaves.
60 days	No fertilizer (control)	65	64	65	52	35	30	15	Roots long, large but few; plants pale green, stunted in growth.
	2.72 grams ammonium sulfate	78	88	78	68	48	44	33	Roots whitish brown, many branches; plants poor, stunted in growth.
	5.43 grams ammonium sulfate	100 (406.5)	100 (123.8 m.)	100 (41.1 cm.)	100 (13.8 g.)	58	53	55	Roots brownish white, long; fair growth; but leaves pale green.
	10.86 grams ammonium sulfate	84	66	91	88	91	78	81	Roots brownish white; plants fair growth, leaves light pale green.
	21.74 grams ammonium sulfate	77	56	77	65	84	100 (340.5)	100 (74.65 g.)	Roots brown, abundant branches; plants dark green, good growth.
	43.48 grams ammonium sulfate	82	42	71	37	100 (85)	92	86	Roots brown, abundant branches; plants dark green, good growth.
75 days	No fertilizer (control)	64	77	62	45	50	41	18	Roots long, large but few; plants pale green, poor growth.
	2.72 grams ammonium sulfate	82	87	75	80	40	43	34	Roots whitish brown, many branches.
	5.43 grams ammonium sulfate	100 (447.5)	100 (131.46 m.)	96	100 (27.7 g.)	68	57	51	Roots brownish white; abundant branches; plants pale green.
	10.86 grams ammonium sulfate	96	87	100 (47.3 cm.)	57	75	70	77	Roots brownish white; abundant branches; plants pale green.
	21.74 grams ammonium sulfate	81	80	77	35	70	65	74	Roots brown, many branches; plants dark green. Some culms destroyed by stem borer.
	43.48 grams ammonium sulfate	95	75	74	31	100 (15)	100 (304)	100 (130.3 g.)	Roots brownish, small size, many branches; plants vigorous, dark green leaves.
90 days	No fertilizer (control)	58	59	61	59	33	37	19	Roots long, large but few; plants pale green with poor growth.
	2.72 grams ammonium sulfate	68	64	72	84	32	43	32	Roots whitish brown many branches; plants poor growth, leaves pale green.
	5.43 grams ammonium sulfate	85	86	89	100 (34.4 g.)	54	64	52	Roots brownish white, long and large; plants pale green, poor growth.
	10.86 grams ammonium sulfate	100 (560.5)	100 (190.99 m.)	89	91	61	48	84	Roots brownish, abundant branches; plants fair growth, leaves pale green.
	21.74 grams ammonium sulfate	94	99	100 (52.9 cm.)	55	70	82	85	Roots brownish, abundant branches; plants vigorous with dark green leaves.
	43.48 grams ammonium sulfate	93	84	83	50	100 (90)	100 (353.5)	100 (130.3 gm.)	Roots brownish, small, many branches; plants vigorous, dark green leaves.

[a] The highest *actual value* under each criterion and under a certain age of the plant was arbitrarily taken as 100; the other actual values under the same criterion were reduced to relative values proportionately.

TABLE 4

Data as relative values[a] *showing the relative development of the roots and tops of the rice plants that received ammonium sulfate fertilizer of different amounts. (Compiled from the data contained in table 2)*

AGE OF PLANTS AT HARVEST	TREATMENT GIVEN	ROOTS				TOPS			EXTERNAL APPEARANCE OF PLANTS
		Number	Total length	Total diameter	Dry weight	Num. of culms	Number of leaves	Dry weight	
15 days	No fertilizer (control)...........	76	99	85	100 (0.03 g.)	100[b]	82	85	Roots whitish brown, few branches; normally developed and green.
	3.35 grams ammonium sulfate...	100 (14.5)	100 (1.22 m.)	100 (0.53 cm.)	88	100	82	100 (0.07 g.)	Roots whitish brown with many branches; plants normally developed and green.
	6.35 grams ammonium sulfate...	90	98	85	84	100	100 (5.5)	83	Roots whitish brown with many branches; plants normally developed and green.
	13.91 grams ammonium sulfate...	83	99	69	32	100	73	62	Roots brown, many branches; plants normal in growth, green leaves.
	23.48 grams ammonium sulfate...	66	49	53	40	100	64	66	Roots whitish brown, few branches; plants normal in growth, green leaves.
	43.48 grams ammonium sulfate...	55	36	51	22	100	73	57	Roots brown, many branches; plants normally developed and green.
30 days	No fertilizer (control)...........	46	45	35	37	32	32	22	Roots whitish, few branches; plants good growth, but light pale green.
	3.35 grams ammonium sulfate...	82	70	70	72	77	78	63	Roots brown, with many branches; plants normally developed and green.
	6.35 grams ammonium sulfate...	100 (84.5)	100 (12.12 m.)	100 (7.00 cm.)	100 (0.54 g.)	100 (11)	97	100 (2.65 g.)	Roots brown with many branches; plants normally developed and green.
	13.91 grams ammonium sulfate...	86	82	80	80	95	100 (34.5)	74	Roots brown, with many branches; plants normally developed and green.
	23.48 grams ammonium sulfate...	82	73	67	63	91	90	59	Roots brown, many branches; plants good growth and dark green.
	43.48 grams ammonium sulfate...	70	52	56	50	86	88	49	Roots brown, small plants vigorous and dark green.
45 days	No fertilizer (control)...........	47	49	22	67	52	37	23	Roots brown, few but long; plants pale green with stunted growth.
	3.35 grams ammonium sulfate...	91	63	89	86	68	78	67	Roots brown, many branches; plants fair growth but pale green leaves.
	6.35 grams ammonium sulfate...	96	97	100 (13.65 cm.)	100 (2.78 g.)	100 (25)	100 (92.5)	100 (11.57 g.)	Roots brown, many branches; fair growth with green leaves.
	13.91 grams ammonium sulfate...	100 (70)	100 (19.02 m.)	91	57	79	78	66	Roots brown, very bulky; plants vigorous growth, dark green.
	23.48 grams ammonium sulfate...	89	75	90	53	70	68	54	Roots brown, very bulky; plants vigorous growth, dark green.
	43.48 grams ammonium sulfate...	88	67	83	63	85	71	69	Roots brown, small, many branches; plants dark green, good growth.
60 days	No fertilizer (control)...........	31	61	35	32	33	29	11	Roots brown, few but long, plants stunted in growth and pale green.
	3.35 grams ammonium sulfate...	63	71	51	54	36	45	31	Roots brown, many branches; plants fair growth but pale green leaves.
	6.35 grams ammonium sulfate...	85	69	87	100 (9.75 g.)	64	70	67	Roots brown; plants vigorous with green leaves.
	13.91 grams ammonium sulfate...	92	88	100 (26.15 cm.)	99	98	92	100 (48.48 g.)	Roots brown, very bulky; plants vigorous growth, dark green.
	23.48 grams ammonium sulfate...	91	100 (50.45 m.)	94	78	100 (43)	100 (172.5)	97	Roots brown, many branches; plants good growth with dark green leaves.
	43.48 grams ammonium sulfate...	100 (280)	85	97	51	93	75	58	Roots brown, small, many branches; plants dark green good growth.
75 days	No fertilizer (control)...........	34	45	36	27	21	17	9	Roots brown, few but long; plants stunted in growth and pale green.
	3.35 grams ammonium sulfate...	49	79	57	51	36	27	18	Roots brown, many branches; plants poor growth, stunted.
	6.35 grams ammonium sulfate...	78	38	81	80	55	45	61	Roots brown color, plants vigorous with green leaves.
	13.91 grams ammonium sulfate...	89	100 (132.3 m.)	90	100 (20.1 g.)	74	72	88	Roots brown, very bulky; plants vigorous growth dark green.
	23.48 grams ammonium sulfate...	73	89	78	97	91	75	91	Roots brown, small; plants vigorous and dark green.
	43.48 grams ammonium sulfate...	100 (425)	75	100 (39.70 cm.)	89	100 (55)	100 (298.0)	100 (126.3 g.)	Roots brown in color, very bulky; abundant branches; plants vigorous, green leaves.
90 days	No fertilizer (control)...........	39	54	51	36	25	16	13	Roots brown, few but long, plants stunted in growth and pale green.
	3.35 grams ammonium sulfate...	51	69	53	42	35	31	26	Roots brown, many branches; plants poor growth, stunted.
	6.35 grams ammonium sulfate...	68	88	81	85	53	41	64	Roots brown color, plants vigorous with green leaves.
	13.91 grams ammonium sulfate...	93	100 (175.43 m.)	93	100 (26.8 g.)	76	68	79	Roots brown, abundant branches; plants vigorous with dark green leaves.
	23.48 grams ammonium sulfate...	96	92	100 48.70 cm.)	80	97	73	95	Roots brown, small; plants vigorous and dark green.
	43.48 grams ammonium sulfate...	100 (517.5)	60	91	73	100 (56.5)	100 (347.5)	100 (179.9 g.)	Roots brown in color, very bulky, abundant branches, with green leaves.

[a] The highest *actual value* under each criterion and under a certain age of the plant was arbitrarily taken as 100; the other actual values under the same criterion were reduced to relative values proportionately.

[b] The actual value is 1 culm.

TABLE 5

Data as relative values[a] *showing the relative development of the roots and tops of the rice plants of different ages that received ammonium sulfate fertilizer of different amounts. (Compiled from the data contained in table 3)*

TREATMENTS GIVEN THE PLANTS	AGE OF PLANTS AT HARVEST	ROOTS				TOPS		
		Number	Total length	Total diameter	Dry weight	Number of culms	Number of leaves	Weight
I Control No fertilizer	*days* 15	4	1	1	0.10	3	3	0.1
	30	24	11	27	2	26	12	5
	45	49	37	53	11	44	48	21
	60	82	71	83	37	76	78	45
	75	88	88	91	77	100 (31)	95	91
	90	100 (323)	100 (113.66 m.)	100 (32.00 cm.)	100 (20.3 g.)	97	100 (29.0)	100 (24.8 g.)
II 2.72 grams ammonium sulfate fertilizer or 0.521 gram nitrogen	15	6	1	4	0.1	9	5	0.3
	30	39	18	43	1.9	62	46	9
	45	55	56	60	15	62	65	36
	60	86	89	85	33	100 (32.5)	97	56
	75	96	94	95	96	75	86	86
	90	100 (380.5)	100 (122.14 m.)	100 (37.35 cm.)	100 (28.9 g.)	89	100 (152.5)	100 (42.2 g.)
III 5.43 grams ammonium sulfate fertilizer or 1.06 grams nitrogen	15	3	1	3	0.11	6	4	0.2
	30	29	12	28	2	43	30	5
	45	57	32	53	10	68	63	28
	60	64	76	87	40	82	81	59
	75	94	80	96	81	87	89	93
	90	100 (475.0)	100 (164.05 m.)	100 (47.10 cm.)	100 (34.8 g.)	100 (48.5)	100 (227.5)	100 (67.7 g.)
IV 10.86 grams ammonium sulfate fertilizer or 2.13 grams nitrogen	15	3	0.7	3	0.08	4	3	0.11
	30	23	10	28	3	40	31	4
	45	50	31	52	12	63	72	29
	60	61	43	72	39	100 (62.5)	98	52
	75	77	60	91	63	74	79	87
	90	100 (560.5)	100 (190.99 m.)	100 (51.90 cm.)	100 (31.1 g.)	87	100 (270.0)	100 (109.8 g.)
V 21.74 grams ammonium sulfate fertilizer or 4.25 grams	15	4	1	3	0.2	4	3	0.4
	30	25	8	27	4	41	25	5
	45	39	25	37	15	60	52	24
	60	59	36	61	47	92	100 (340.5)	67
	75	69	55	69	63	68	58	83
	90	100 (529.5)	100 (189.47 m.)	100 (52.90 cm.)	100 (19.0 g.)	100 (63.5)	85	100 (111.2 g.)
VI 43.48 grams ammonium sulfate fertilizer or 8.51 grams nitrogen	15	3	1	3	0.1	3	2	0.07
	30	22	7	25	4	26	20	3
	45	32	17	38	13	40	47	16
	60	63	32	66	34	76	89	47
	75	80	91	80	71	68	88	95
	90	100 (529.5)	100 (160.81 m.)	100 (44.00 cm.)	100 (17.2 g.)	100 (90.0)	100 (353.5)	100 (130.2 g.)

[a] The highest *actual value* under each criterion and under a certain age of the plant was arbitrarily taken as 100; the other actual values under the same criterion were reduced to relative values proportionately.

TABLE 6

Data as relative values[a] showing the relative development of the roots and tops of the rice plants of different ages that received ammonium sulfate fertilizer of different amounts. (Compiled from the data contained in table 4)

TREATMENTS GIVEN THE PLANTS	AGE OF PLANTS AT HARVEST	ROOTS				TOPS		
		Number	Total length	Total diameter	Dry weight	Number of culms	Number of leaves	Dry weight
	days							
I Control No fertilizer	15	5	0.1	2	0.3	7	7	0.2
	30	19	6	9	2	25	21	2
	45	32	9	12	20	89	58	12
	60	43	32	36	33	99	89	23
	75	71	69	58	57	78	89	44
	90	100	100	100	100	100	100	100
		(203.5)	(96.11 m.)	(24.85 cm.)	(9.1 g.)	(14)	(56.5)	(23.6 g.)
II 3.36 grams ammonium sulfate fertilizer or 0.66 gram nitrogen	15	5	1	2	0.2	5	4	1
	30	25	7	18	4	42	25	3
	45	46	10	45	22	80	67	15
	60	65	31	55	69	77	72	30
	75	76	87	94	93	97	75	45
	90	100	100	100	100	100	100	100
		(272.0)	(121.80 m.)	(27.00 cm.)	(11.0 g.)	(20)	(107.0)	(49.7 g.)
III 6.35 grams ammonium sulfate fertilizer or 1.24 grams nitrogen	15	3	0.7	1	0.07	3	4	0.4
	30	23	8	19	2	35	25	2
	45	37	12	39	12	76	65	10
	60	65	22	64	43	88	84	28
	75	90	31	91	76	100	93	67
	90	100	100	100	100	100	100	100
		(365.0)	(156.23 m.)	(35.45 cm.)	(22.7 g.)	(31)	(142.5)	(116.6 g.)
IV 13.91 grams ammonium sulfate fertilizer or 2.70 grams nitrogen	15	2	0.6	1	0.03	2	2	0.2
	30	15	6	12	2	23	14	1
	45	28	11	27	6	41	30	4
	60	52	25	58	36	94	67	34
	75	77	75	79	79	93	90	79
	90	100	100	100	100	100	100	100
		(495.0)	(175.43 m.)	(45.25 cm.)	(26.8 g.)	(44.5)	(237.5)	(141.9 g.)
V 23.48 grams ammonium sulfate fertilizer or 4.59 grams nitrogen	15	5	0.4	0.6	0.04	2	1	0.3
	30	10	5	10	2	19	12	0.9
	45	24	9	25	7	34	24	4
	60	54	31	51	35	83	68	28
	75	64	73	63	92	96	97	68
	90	100	100	100	100	100	100	100
		(508.5)	(161.35 m.)	(48.70 cm.)	(21.3 g.)	(52)	(253.5)	(170.1 g.)
VI 43.48 grams ammonium sulfate fertilizer or 8.51 grams nitrogen	15	1	0.4	0.6	0.03	2	1	0.2
	30	10	6	9	1	16	9	0.7
	45	24	12	26	9	34	19	4
	60	52	40	57	25	68	37	15
	75	79	96	89	93	94	86	71
	90	100	100	100	100	100	100	100
		(517.5)	(151.38 m.)	(44.20 cm.)	(19.5 g.)	(58.5)	(347.5)	(179.9 g.)

[a] The highest *actual value* under each criterion and under a certain age of the plant was arbitrarily taken as 100; the other actual values under the same criterion were reduced to relative values proportionately.

TABLE 7

The highest actual values under each criterion on root yields shown in tables 5 and 6 were reduced to their corresponding relative values.[a] *The results are shown in this table*

CULTURE NUMBER		AMOUNT OF AMMONIUM SULFATE USED	AGE OF PLANTS	NUMBER OF ROOTS		TOTAL LENGTH OF ROOTS		TOTAL DIAMETER OF ROOTS		DRY WEIGHT OF ROOTS	
				a[b]	b[c]	a	b	a	b	a	b
		grams	*days*								
I	(a)[b]										
	(b)[c]	None	90	57	39	60	55	60	51	59	34
II	(a)	2.72									
	(b)	3.35	90	67	53	64	69	71	55	85	41
III	(a)	5.43									
	(b)	6.35	90	84	71	86	89	89	73	100 (34.3 g.)	85
IV	(a)	10.86									
	(b)	13.91	90	100 (560.5)	96	100 (190.99 m.)	100 (175.43 m.)	98	93	91	100 (26.8 g.)
V	(a)	21.74									
	(b)	23.48	90	95	98	99	92	100 (52.9 cm.)	100 (48.7 cm.)	56	77
VI	(a)	43.48									
	(b)	43.48	90	95	100 (517.5)	88	86	83	91	50	73

[a] The highest actual value under each criterion was arbitrarily considered as 100; the other actual values under the same criterion were reduced to relative values proportionately.

[b] The data shown under *a* were taken from table 5.

[c] The data shown under *b* were taken from table 6.

A STUDY OF THE CHEMICAL COMPOSITION OF FOUR SUGAR CANE VARIETIES OF THE SAME AGE AND GROWN UNDER SIMILAR CONDITIONS[1]

FRANCISCO V. DEOMANO

WITH ONE CHART

INTRODUCTION

Evans (1847) reported that during the rapid vegetative growth of sugar cane, *Saccharum officinarum*, L. the saccharine matter is reabsorbed from the cells almost as rapidly as it is deposited in them, and is used to nourish the plant and provide materials for the formation of new parts. When the cane growth has ceased, however, the cells abound in sucrose and the saline materials which are greatly needed during the growing stage are in little demand at the ripening period.

It has long been known that the constituents vary with the age of the cane, but Geerligs (1924) found that they vary also with weather conditions, soil fertility and variety of cane. On account of these varying peculiarities, a chemical study of the common sugar cane varieties should be of great aid in determining the time for cutting the cane so that it will give the highest purity juices for sugar manufacture.

Review of literature

The earliest work in chemical analysis of sugar cane was done by Maxwell in Hawaii and by Agee and Halligan in Louisiana. Noel Deerr (1921) found that with respect to a single cane variety the composition will be found to lie within the following limits: water, 69 to 75 per cent: sugar, 7 to 20 per cent: reducing sugars, zero to 2 per cent: fibre, 8 to 17 per cent: ash, 0.3 to 0.8 per cent: and the organic non-sugar, 0.5 to 1 per cent. Mirasol (1915) concluded that during the ripening period of the sugar cane a point is reached when the purity is very high, the sucrose content at its maximum, and the reducing sugar at its minimum. He concluded further that after this point is reached and maintained for a length of time which depends on the variety of the cane, and the soil and climate conditions, the purity and sucrose content decrease and the reducing sugar increases.

According to Geerligs (1924) an over-ripe cane has a decreasing sucrose in the bottom joints, a rapid rise in the higher joints, an irregular percentage in the intermediate joints, and a maximum near the top. He estimated that on the whole the average sucrose is lower in the over-ripe cane than in the ripe. Geerligs also worked on the influence of arrowing on the composition of the cane and found that it is disadvantageous, for the cane is likely to die after it has arrowed.

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[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Sugar Technology from the College of Agriculture No. 395. Experiment Station contribution No. 727. Prepared in the Department of Agricultural Chemistry under the direction of Professor Reginald H. King.

McGeorge (1923) concluded that the composition of plant mineral matter varies at different periods of growth, and that the amount of mineral nutrients which a soil must furnish to a crop in the earlier stages of growth is greater than the amount needed at maturity.

Verret (1923) working on the effect of phosphoric acid and potash on the quality of cane juices, concluded that phosphoric acid favors early ripening of crops while potash delays it. The work of Verret is in a measure supported by Alexander (1926) who, working on the influence of potash fertilization on the sucrose content of sugar cane, expressed the opinion that potash fertilizers improve the sugar cane yield and also increase sucrose content.

Noel Deerr (1921) reported that the nodes and internodes vary in their sucrose and glucose contents, with the latter supplying the greater amount. The amount of ash from the different parts of the cane was found to differ considerably. Analysis of Hawaiian canes as reported by Noel Deerr shows that the leaves have the highest percentage of ash. Geerligs concluded from the data reported by various workers that the sugar cane absorbs very little mineral substances from the soil. He found that the quantity and quality of inorganic constituents of the cane depend largely upon the character of the soil.

According to Evans (1847) the sugar cane plant absorbs with great readiness the chlorides of sodium and potassium, and the sodium forms a deliquiescent compound which accounts for the difficulty of obtaining sugar that will crystallize freely.

Object of the present work

The present work had for its main object the finding of the chemical composition of four sugar cane varieties with relation to age.

Time and place of the present work

The work was done in the laboratory of the U. P. Sugar Mill, College of Agriculture, University of the Philippines, from September 1929 to June 1930, a period of about ten months.

MATERIALS AND METHODS

Sugar cane varieties used

There were four sugar cane varieties used in this work: namely, Luzon White, Badila, Mauritius 1900 and Negros Purple.

The canes were planted on February 10, 1929, and 200 pounds of commercial ammonium sulfate fertilizer per hectare were applied at the time of planting.

Sampling

The four cane varieties used in this work were planted at the same time in a field, approximately half a hectare in area. The varieties were arranged in rows in such a way that a row of one variety was adjacent to rows of two other varieties. The field was cleaned and the oldest stalk from each stool was properly labeled to distinguish it from other stalks in the same stool. For each analysis, ten to twelve of the oldest stalks from ten to twelve stools were cut at random and as close to the ground as possible. The millable parts of the stalks were separated from the leaves at the last visible node and were divided into five equal parts, constituting five samples. These five samples were named according to their position in the whole cane stalk as: bottom, upper bottom, middle, lower top and top. The upper bottom is between the middle and the extreme bottom while the lower top is between the middle and the highest joints. The leaves and leaf sheaths were taken as a sample, and the remainder which was called the "seeds" formed another sample. The five samples from the millable portion were quartered longitudinally and the two opposite quarters were used for ash and moisture determinations, while the remainder was used for glucose and sucrose analysis. The samples for organic analysis were separately passed between the rollers of a small hand mill and the juices were collected in suitable containers. The juice analysis was made immediately after extracting the juice so as to prevent losses from inversion.

Methods of analysis

Moisture. The materials for moisture determination were chopped fine so as to obtain a representative sample. Fifty to seventy grams of the chopped materials were placed in a tared container and heated to constant weight in an electric oven at 105°C. The loss in weight was considered the weight of moisture. The dried materials were placed in properly corked Erlenmeyer flasks for ash determination.

Ash. The dry material from the moisture determination was weighed and placed in nickel crucibles. The crucibles were placed in an electric furnace of high temperature for five hours or more until all the volatile matter had evaporated and the remaining material was almost white. The ash was transferred into vials, placed in a desiccator and weighed. The weight of the ash divided by the weight of its corresponding dry matter gives the amount of ash per unit weight of the dry material.

Purities. The sucrose was determined by Walker's inversion method. The Brix was found by the use of the Brix spindle. The apparent and gravity purities were obtained by dividing polarization and sucrose by the corrected Brix.

The refractometer solids were determined by the use of a hand refractometer.

Glucose. For the glucose determination the Methylene Blue method was used.

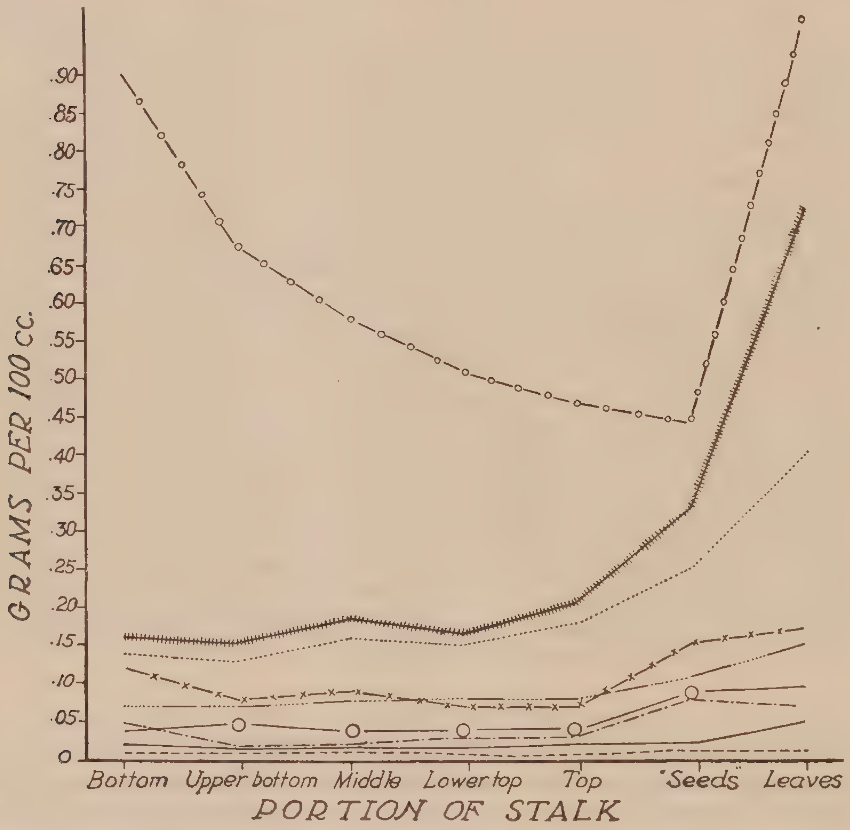

Chart 1.—Showing the relative concentrations of the different inorganic constituents per 100 cc. of water in the different portions of the sugar cane stalks. The figures were taken as the average of the four varieties analyzed.

LEGEND:

——————— CaO
—×—×—×— Al_2O_3
—·—·—·— MgO
—o—o—o— SiO_2
- - - - - - - - - Na_2O
|-|-|-|-|-|-|-|-|-| K_2O
— — — — — — Fe_2O_3
—·-·—·-·— P_2O_5
——O—— SO_4

Inorganic constituents. The inorganic constituents were determined according to the *Official Methods of Analyses* of the Association of Official Agricultural Chemists.

RESULTS OF THE DETERMINATIONS

The results are given in tabulated form and are arranged as follows: Table 1 shows the analyses of Luzon White at different ages. In this table are included all the results of organic determinations, the percentage of moisture based on cane, and the percentage of ash based on dry matter. Table 2 contains the results for Badila, table 3 for Mauritius 1900 and table 4 for Negros Purple.

Tables 5, 6, 7 and 8 show the amount of inorganic constituents in one hundred parts dry matter at different ages. Table 5 gives the results for Luzon White, table 6 for Badila, table 7 for Mauritius 1900, and table 8 for Negros Purple.

Chart 1 shows the relative concentrations of the different inorganic constituents per 100 cc. of water in the different portions of the sugar cane stalks. The figures were taken as the average of the four varieties analyzed.

DISCUSSION OF RESULTS

Generalization based on the results

In the first set of analyses a marked difference was noticed between the sucrose contents of the bottoms and of the tops. The differences were found to be 1.79 in Luzon White; 4.36 in Badila; 4.23 in Mauritius 1900; and 3.13 in Negros Purple. These differences, however, did not hold true in the succeeding analyses where the differences were slight, being only in tenths of one per cent. Considering the fact that no appreciable increase or decrease took place in the bottom joints, the small differences may be due only to the increasing sucrose in the top joints. The apparent and gravity purities followed the same trend of deviation as the sucrose did. While in the first set of analyses the difference in the glucose contents between the top and the bottom was great, the succeeding experiments showed a very narrow difference. Of the four varieties analysed, only Luzon White showed definite cases where the glucose content was greater at the bottom than it was at the top.

The percentage of moisture ranged from a minimum of 62.01 in the leaves to a maximum of 80.33 in the seeds. The amount of ash based on dry matter varied from 1.76 per cent up to 14.97 per cent with the leaves giving the highest percentage.

The amounts of inorganic constituents obtained from ash analyses of the four varieties, varied considerably. The greatest portion of the sugar cane ash, particularly the ash from the leaves, was found to be composed of silicon dioxide, (SiO_2). The phosphoric anhydride, (P_2O_5), and the combined iron and aluminum oxides were found to be present in approximately the same amounts. With the exception of iron oxide, all the other elements had a tendency for greater accumulation in the leaves and in the "seeds" than in any other part of the sugar cane stalk.

Interpretation of results

During the course of the experiment it was found that Luzon White at the age of ten months gave relatively low percentages of sucrose in comparison with the percentages in the previous and succeeding analyses. These low percentages may be due to the fact that the canes were cut during rainy weather when the plants were induced to prolong vegetative growth at the sacrifice of the stored sucrose.

It appears from the accompanying results that in the early part of the year a greater amount of sucrose is stored at the bottom joints than at the top joints of a sugar cane stalk. If the canes are allowed to remain in the field and subjected to ordinary conditions, the sucrose content of the top joints will be found to approach that of the bottom joints. This uniformity in sucrose distribution in the different portions of a millable stalk suggests the best time for harvesting the canes. The results show that when the sucrose content is fairly uniform throughout the stalk the juice purity is relatively high in comparison with the juice purity when the sucrose in cane is unevenly distributed.

Correlation of organic with inorganic constituents

Considering the relatively low sucrose content of Luzon White as compared with that of the other three varieties, no indication could be seen for the existence of certain relationship between the organic and inorganic constituents. There are differences in the inorganic constituents among the four sugar cane varieties analyzed, but such differences are very irregular and in a relatively small amount that could not be correlated with any of the organic constituents. It was noted, however, that the amount of ash per unit weight of the dry material bears a direct relation to the amount of silica present. If a high percentage of ash is obtained from a given sample, a high percentage of silica may be expected.

SUMMARY AND CONCLUSIONS

1. Four sugar cane varieties; namely, Luzon White, Badila, Mauritius 1900 and Negros Purple, of the same age and grown under similar conditions were analyzed for some organic and inorganic constituents.
2. Luzon White contained low purity juice as compared with the juice purities of the other three varieties.
3. When the canes are young there is a great difference in the sucrose contents of the top and bottom, but as the canes mature the amount of sucrose is fairly uniform in the different portions of a millable stalk.
4. As the cane matures the differences in glucose content of the different portions of the stalk decrease.
5. A wide variation was found in the inorganic constituents of the four varieties analyzed.
6. Silica constitutes the greatest portion of the sugar cane ash, particularly of the ash of the leaves and leaf sheaths.
7. With the exception of iron oxide, all the other inorganic elements have a tendency to accumulate more in the "seeds" and in the leaves than in any other part of a sugar cane stalk.

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TABLE 1

Showing the analysis of Luzon White at different ages

PORTION OF STALK	AGE IN MONTHS	BRIX	POLARIZATION	SUCROSE IN JUICE	POL'N. IN CANE	GLUCOSE IN JUICE	REFRACTOMETER SOLIDS	APPARENT PURITY	GRAVITY PURITY	MOISTURE IN CANE	ASH IN DRY MATTER
										per cent	*per cent*
Bottom........	9 months	17.29	15.46	15.72	14.02	0.127	16.50	89.42	90.92	67.30	4.22
Upper bottom..	9 months	17.76	15.86	16.11	14.38	0.331	17.00	89.32	90.72	65.97	4.27
Middle.........	9 months	17.71	15.45	15.77	14.01	0 483	17.00	87.22	89.03	71.21	3.67
Lower top.....	9 months	17.61	15.43	15.79	13.99	0.644	17.30	87.61	89.65	70.50	3.20
Top...........	9 months	17.11	13.56	13.93	12.30	0.889	15.50	84.16	86.32	73.43	3.07
"Seeds".......	9 months		4.13							79.43	5.38
Leaves........	9 months		1.56							62.20	8.97
Bottom........	10 months	12.9	11.22	11.29	10.17	0.274	12.50	86.97	87.52	69.68	5.74
Upper bottom..	10 months	11.82	9.87	10.01	8.95	0.361	11.00	83.50	84.69	73.20	5.16
Middle........	10 months	12.42	10.49	10.69	9.51	0.331	11.50	84.46	86.07	73.52	4.76
Lower top.....	10 months	13.52	11.62	11.76	10.54	0.318	13.00	85.95	86.98	72.60	4.17
Top...........	10 months	13.47	11.27	11.47	10.22	0.469	13.50	83.67	85.15	73.38	4.30
"Seeds".......	10 months		6.53							78.16	5.74
Leaves........	10 months		1.05							63.06	10.02
Bottom........	12 mo. 10 days	17.14	15.26	15.56	13.84	0.604	17.50	89.03	89.22	70.01	3.01
Upper bottom..	12 mo. 10 days	14.44	12.46	12.71	11.30	0.861	14.50	86.28	88.01	74.53	3.10
Middle........	12 mo. 10 days	15.74	13.80	14.05	12.51	0.558	15.50	87.67	89.26	70.65	2.71
Lower top.....	12 mo. 10 days	17.04	15.02	15.31	13.62	0.398	16.50	88.15	89.85	70.74	2.46
Top	12 mo. 10 days	17.74	15.57	15.81	14.12	0.239	17.50	87.77	89.12	69.35	2.87
"Seeds".......	12 mo. 10 days		8.46							69.76	4.02
Leaves........	12 mo. 10 days		1.04							62.18	9.23
Bottom........	14 months	18.36	16.32	16.46	13.84	0.586		88.88	89.65		
Upper bottom..	14 months	15.56	13.12	13.27	11.90	0.980		84.36	85.28		
Middle........	14 months	15.26	13.25	13.33	12.03	0.824		86.82	87.35		
Lower top.....	14 months	16.46	14.37	14.59	13.03	0.746		87.30	88.63		
Top...........	14 months	17.86	15.81	16.03	14.34	0.533		88.52	89.75		

TABLE 2

Showing the analysis of Badila at different ages

PORTION OF STALK	AGE IN MONTHS	BRIX	POLARIZATION	SUCROSE IN JUICE	POL'N. IN CANE	GLUCOSE IN JUICE	REF. SOLIDS IN JUICE	APPARENT PURITY	GRAVITY PURITY	MOISTURE IN CANE	ASH IN DRY MATTER
										per cent	*per cent*
Bottom........	9 months	19.80	18.77	18.91	16.93	0.371	19.50	94.79	95.50	68.71	0.01
Upper bottom..	9 months	20.86	19.17	19.32	17.29	0.471	20.50	91.89	92.62	69.47	2.06
Middle........	9 months	20.66	19.18	19.41	17.30	0.790	20.00	92.83	93.99	70.11	1.95
Lower top.....	9 months	19.76	17.41	17.72	15.70	1.130	19.00	88.10	89.68	69.87	1.88
Top...........	9 months	17.66	14.21	14.55	12.81	1.780	17.40	80.46	82.37	71.82	2.37
"Seeds".......	9 months		3.22							74.64	4.52
Leaves........	9 months		0.81							64.20	7.65
Bottom........	10 months	18.32	16.84	17.01	15.18	0.215	17.50	91.92	92.85	70.54	3.20
Upper bottom..	10 months	19.00	17.69	17.71	15.95	0.298	18.50	93.11	93.21	72.34	2.37
Middle........	10 months	18.90	17.30	17.51	15.60	0.483	18.50	91.53	92.65	71.32	2.01
Lower top.....	10 months	19.00	16.93	16.96	15.27	1.020	18.50	89.11	89.26	73.14	2.19
Top...........	10 months	18.40	16.09	16.14	14.51	1.420	17.50	87.45	87.72	74.30	2.50
"Seeds".......	10 months		10.49							76.78	4.02
Leaves........	10 months		0.38							71.90	——
Bottom........	12 mo. 11 days	19.77	18.49	18.75	16.67	0.652	19.50	93.53	94.84	68.01	2.12
Upper bottom.	12 mo. 11 days	20.37	18.90	19.28	17.04	0.877	20.00	92.78	94.65	67.63	——
Middle........	12 mo. 11 days	20.67	19.41	19.76	17.50	0.689	20.50	93.90	95.59	68.93	1.86
Lower top.....	12 mo. 11 days	21.79	20.39	20.68	18.39	0.669	21.50	93.57	94.90	66.30	1.78
Top...........	12 mo. 11 days	22.00	20.41	20.79	18.40	0.703	21.50	92.77	94.50	68.00	1.76
"Seeds".......	12 mo. 11 days		10.68							70.72	——
Leaves........	12 mo. 11 days		0.87							62.01	8.98
Bottom........	14 months	20.63	19.38	19.64	17.48	0.468		93.94	95.20		
Upper bottom..	14 months	19.83	18.75	19.08	16.91	0.524		94.55	96.21		
Middle........	14 months	20.33	19.36	19.55	17.46	0.539		95.22	96.16		
Lower top.....	14 months	20.13	19.26	19.50	17.37	0.491		95.67	96.87		
Top...........	14 months	19.83	18.68	18.92	16.84	0.502		94.20	95.41		

TABLE 3

Showing the analysis of Mauritius 1900 at different ages

PORTION OF STALK	AGE IN MONTHS	BRIX	POLARIZATION	SUCROSE IN JUICE	POL'N. IN CANE	GLUCOSE IN JUICE	REFRACTOMETER SOLIDS	APPARENT PURITY	GRAVITY PURITY	MOISTURE IN CANE	ASH IN DRY MATTER
										per cent	*per cent*
Bottom........	9 months	20.13	18.97	19.12	17.23	0.226	19.50	94.23	94.98	68.33	4.41
Upper bottom..	9 months	20.53	19.33	19.57	17.56	0.378	20.50	94.15	95.32	70.17	2.01
Middle........	9 months	20.02	18.70	18.89	16.99	0.530	19.50	93.40	94.35	69.33	2.21
Lower top.....	9 months	19.12	17.29	17.41	15.71	0.890	18.50	90.42	91.05	70.60	2.42
Top...........	9 months	17.12	14.40	14.89	13.08	1.210	16.50	84.11	86.97	72.71	3.75
"Seeds".......	9 months		5.16							80.33	6.36
Leaves........	9 months		2.39							68.22	6.46
Bottom........	10 months	19.13	17.79	18.09	16.16	0.141	18.60	92.99	93.72	71.48	3.56
Upper bottom..	10 months	18.48	17.44	17.58	15.84	0.167	17.90	94.37	95.12	73.76	—
Middle...	10 months	18.68	17.46	17.59	15.86	0.313	18.00	93.46	94.16	74.36	2.58
Lower top.....	10 months	18.57	17.08	17.25	15.52	0.398	17.90	91.97	92.89	74.28	1.95
Top...........	10 months	17.88	15.81	16.13	14.36	0.847	17.50	88.42	90.21	73.40	2.28
"Seeds".......	10 months		9.12							79.04	4.81
Leaves........	10 months		0.98							71.78	11.02
Bottom........	12 mo. 12 days	20.35	18.78	18.97	17.06	0.361	19.70	92.28	93.21	72.32	2.58
Upper bottom..	12 mo. 12 days	18.26	16.24	16.61	14.75	0.567	17.50	88.93	90.96	70.50	3.78
Middle........	12 mo. 12 days	18.46	16.61	16.82	15.09	0.544	17.50	89.97	91.11	70.20	3.16
Lower top.....	12 mo. 12 days	19.48	17.89	18.01	16.25	0.454	19.50	91.83	92.45	69.48	2.64
Top...........	12 mo. 12 days	20.19	18.75	18.90	17.03	0.433	20.20	92.86	93.61	71.46	2.57
"Seeds".......	12 mo. 12 days		7.33							72.26	4.55
Leaves........	12 mo. 12 days		0.96							66.60	
Bottom........	14 months	20.46	19.38	19.64	17.61	0.479		93.79	94.23		
Upper bottom..	14 months	19.56	18.75	19.08	17.03	0.497		93.96	95.19		
Middle........	14 months	19.36	19.36	19.55	17.59	0.533		93.64	94.00		
Lower top.....	14 months	19.76	19.26	19.50	17.50	0.539		93.57	94.63		
Top...........	14 months	20.06	18.68	18.92	16.97	0.487		93.36	94.31		

TABLE 4

Showing the analysis of Negros Purple at different ages

PORTION OF STALK	AGE IN MONTHS	BRIX	POLARIZATION	SUCROSE IN JUICE	POL'N. IN CANE	GLUCOSE IN JUICE	REFRACTOMETER SOLIDS	APPARENT PURITY	GRAVITY PURITY	MOISTURE IN CANE	ASH IN DRY MATTER
										per cent	*per cent*
Bottom	9 months	18.89	17.56	17.69	14.84	0.313	18.50	92.95	93.64	66.04	3.79
Upper bottom	9 months	19.30	18.18	18.32	15.36	0.471	18.90	94.19	94.92	67.41	2.93
Middle	9 months	19.10	17.74	17.82	14.99	0.626	18.80	92.87	93.92	69.61	1.98
Lower top	9 months	18.51	16.90	17.06	14.28	0.746	18.50	91.30	92.16	68.31	1.95
Top	9 months	16.80	14.34	14.56	12.11	1.18	16.00	85.35	86.66	67.15	1.96
"Seeds"	9 months		5.68							70.14	——
Leaves	9 months		0.99							64.46	6.99
Bottom	10 months	19.45	18.20	18.35	15.38	0.144	18.70	93.57	94.34	70.29	2.51
Upper bottom	10 months	18.85	17.49	17.59	14.78	0.168	18.00	92.78	93.31	73.84	2.17
Middle	10 months	18.32	16.85	16.95	14.24	0.240	17.50	91.97	92.52	75.30	1.83
Lower top	10 months	18.32	16.68	16.82	14.09	0.399	17.50	91.04	91.81	72.32	2.09
Top	10 months	17.52	15.53	15.72	13.12	0.637	17.00	88.64	89.72	74.12	2.22
"Seeds"	10 months		10.53							76.36	4.37
Leaves	10 months		1.21							62.66	11.27
Bottom	12 mo. 13 days	19.87	18.00	18.32	15.21	0.628	19.50	90.58	92.19	75.56	3.24
Upper bottom	12 mo. 13 days	19.37	17.43	17.72	14.73	0.752	19.00	89.98	91.48	72.20	3.66
Middle	12 mo. 13 days	19.08	17.00	17.29	14.36	0.895	18.70	89.09	90.61	70.26	3.11
Lower Top	12 mo. 13 days	18.28	15.90	16.27	13.43	1.202	18.00	86.98	89.00	71.62	2.88
Top	12 mo. 13 days	19.28	17.46	17.72	14.75	0.806	19.00	90.56	91.90	71.76	2.88
"Seeds"	12 mo. 13 days		9.19							74.24	3.21
Leaves	12 mo. 13 days		1.40							65.12	14.97

TABLE 5

Showing the amount of inorganic constituents in 100 parts dry matter of Luzon White at different ages

PORTION OF STALK	AGE IN MONTHS	SiO_2	P_2O_5	Na_2O	K_2O	Fe_2O_3 Al_2O_3	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3
Bottom........	9 months	1.776	0.098	0.285	0.287	0.198	0.033	0.165	0.102	0.079	0.047
Upper bottom..	9 months	1.557	0.106	0.167	0.321	0.525	0.084	0.441	0.059	0.053	0.091
Middle........	9 months	1.878	0.172	0.574	0.909	0.606	0.076	0.530	0.085	0.077	0.116
Lower top.....	9 months	0.828	0.104	0.150	0.299	0.180	0.019	0.161	0.046	0.056	0.052
Top...........	9 months	1.475	0.211	0.292	0.746	0.331	0.039	0.292	0.094	0.113	0.082
"Seeds"......	9 months	1.876	0.314	0.742	1.545	0.093	0.103	0.990	0 131	0.201	0.167
Leaves........	9 months	6.517	0.227	0.541	1.397	0.263	0.029	0.234	0.204	0.176	0.125
Bottom........	10 months	3.667	0.234	0.536	0.551				0.092	0.069	0.142
Upper bottom..	10 months	3.071	0.348	0.541	0.559	0.085	0.060	0.025	0.063	0.083	0.172
Middle........	10 months	2.675	0.347	0.734	0.789	0.051	0.036	0.015	0.050	0.057	0.175
Lower top.....	10 months	2.502	0.252	0.615	0.390	0.056	0.014	0.042	0.040	——	0.196
Top...........	10 months	0.980	0.239	0.624	0.391	0.064	0.012	0.052	0.045	0.043	0.175
"Seeds".......	10 months	4.148	0.351	0.537	0.601	0.098	0.017	0.081	0.096	0.189	0.316
Leaves........	10 months	8.296	0.305	0.586	0.641	0.075	0.017	0.058	0.041	0.063	0.158
Bottom........	12 mo. 10 days	1.940	0.160	0.648	0.751	0.128	0.020	0.108	0.071	0.058	0.157
Upper bottom..	12 mo. 10 days	1.700	0.151	0.763	0.746	0.120	0.019	0.101	0.061	0.048	0.164
Middle........	12 mo. 10 days	1.424	0.170	0.669	0.647	0.316	0.006	0.310	0.066	0.027	0.115
Lower top.....	12 mo. 10 days	1.373	0.164	0.635	0.548	0.262	0.008	0.254	0.054	0.039	0.090
Top...........	12 mo. 10 days	1.591	0.189	0.647	0.506	0.153	0.006	0.147	0.078	0.066	0.053
"Seeds".......	12 mo. 10 days	1.442	0.410	0.210	1.204	0.498	0.007	0.491	0.126	0.065	0.171
Leaves........	12 mo. 10 days	5.827	0.287	1.960	1.903	0.418	0.010	0.408	0.160	0.102	0.143

TABLE 6

Showing the amount of inorganic constituents in 100 parts dry matter of Badila of different ages

PORTION OF STALK	AGE IN MONTHS	SiO_2	P_2O_5	Na_2O	K_2O	Fe_2O_3 Al_2O_3	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3
Bottom........	9 months	2.048	0.103	0.107	0.244	0.308	0.013	0.295	0.011	0.017	0.032
Upper bottom.	9 months	1.439	0.093	0.081	0.255	0.059	0.012	0.047	0.010	0.018	0.039
Middle........	9 months	1.148	0.116	0.137	0.379	0.056	0.011	0.045	0.009	0.015	0.045
Lower top....	9 months	1.087	0.133	0.140	0.397	0.033	0.008	0.025	0.006	0.019	0.039
Top...........	9 months	0.978	0.169	0.283	0.727	0.104	0.009	0.095	0.016	0.031	0.083
"Seeds".......	9 months	1.371	0.264	0.712	1.894	0.193	0.013	0.179	0.020	0.039	0.194
Leaves........	9 months	5.378	0.248	0.583	1.325	0.141	0.014	0.127	0.074	0.063	0.190
Bottom........	10 months	2.344	0.146	0.259	0.260	0.387	0.051	0.335	0.010	0.017	0.023
Upper bottom.	10 months	1.478	0.143	0.258	0.257	0.269	0.028	0.241	——	——	0.039
Middle........	10 months	1.577	0.138	0.280	0.250	0.267	0.013	0.253	0.002	0.020	0.032
Lower top.....	10 months	1.647	0.188	0.392	0.422	0.238	0.014	0.225	0.009	0.008	0.032
Top...........	10 months	0.891	0.229	0.398	0.470	0.230	0.015	0.215	0.009	0.014	0.035
"Seeds".......	10 months	1.205	0.355	0.468	0.540	0.484	0.011	0.474	0.020	0.025	0.164
Leaves........	10 months	5.200	0.237	0.410	0.840	0.389	0.010	0.379	0.041	0.043	0.165
Bottom........	12 mo. 11 days	1.503	0.133	0.223	0.195	0.207	0.013	0.184	0.031	0.040	0.036
Upper bottom..	12 mo. 11 days	1.291	0.109	0.212	0.184	0.083	0.010	0.073	0.033	0.011	0.062
Middle........	12 mo. 11 days	1.222	0.141	0.269	0.235	0.076	0.014	0.062	0.033	0.008	0.041
Lower top.....	12 mo. 11 days	1.097	0.178	0.300	0.263	0.096	0.011	0.085	0.031	0.012	0.057
Top...........	12 mo. 11 days	0.882	0.191	0.439	0.421	0.059	0.009	0.050	0.024	0.020	0.112
"Seeds".......	12 mo. 11 days	1.266	0.267	0.913	0.752	0.157	0.016	0.141	0.053	0.078	0.193
Leaves........	12 mo. 11 days		0.341		1.813	0.374	0.012	0.362	0.045	0.038	0.210

TABLE 7

Showing the amount of inorganic constituents in 100 parts dry matter of Mauritius 1900 at different ages

PORTION OF STALK	AGE IN MONTHS	SiO_2	P_2O_5	Na_2O	K_2O	Fe_2O_3 Al_2O_3	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3
Bottom........	9 months	2.913	0.180	0.241	0.261	0.548	0.041	0.507	0.146	0.120	0.085
Upper bottom..	9 months	1.070	0.178	0.117	0.273	0.332	0.056	0.276	0.106	0.092	0.077
Middle........	9 months	1.052	0.216	0.138	0.312	0.398	0.074	0.324	0.097	0.106	0.073
Lower top.....	9 months	1.030	0.234	0.175	0.453	0.462	0.108	0.354	0.114	0.151	0.097
Top...........	9 months	1.638	0.318	0.308	0.792	0.575	0.084	0.491	0.154	0.224	0.188
"Seeds".......	9 months	1.883	0.501	0.848	1.900	0.630	0.128	0.502	0.305	0.318	0.434
Leaves........	9 months	3.586	0.311	0.470	1.423	0.268	0.057	0.211	0.243	0.197	0.189
Bottom........	10 months	2.027	0.228	0.372	0.389	0.719	0.052	0.667	0.096	0.126	0.122
Upper bottom..	10 months	——	0.234	0.412	0.363	0.417	0.026	0.391	0.083	0.076	0.115
Middle........	10 months	1.194	0.269	0.547	0.343	0.394	0.019	0.375	0.089	0.084	0.096
Lower top.....	10 months	0.834	0.155	0.431	0.438	0.355	0.014	0.341	0.032	0.048	0.083
Top...........	10 months	0.541	0.215	0.528	0.545	0.416	0.013	0.403	0.047	0.040	0.130
"Seeds".......	10 months	1.483	0.409	1.110	1.365	0.925	0.012	0.913	0.040	0.045	0.419
Leaves........	10 months	4.679	0.214	——	——	0.436	0.038	0.398	0.051	0.069	0.142
Bottom........	12 mo. 12 days	1.502	0.249	0.383	0.323	0.298	0.037	0.261	——	——	0.097
Upper bottom..	12 mo. 12 days	1.802	0.275	——	——	0.431	0.016	0.415	0.042	0.124	0.166
Middle........	12 mo. 12 days	1.661	0.285	0.419	0.536	0.348	0.012	0.336	0.071	0.102	0.133
Lower top.....	12 mo. 12 days	1.328	0.284	0.644	0.355	0.217	0.012	0.205	0.071	0.125	0.132
Top...........	12 mo. 12 days	1.177	0.318	0.803	0.438	0.203	0,012	0.191	0.053	0.115	0.105
"Seeds".......	12 mo. 12 days	2.179	0.418	0.760	0.634	0.663	0.007	0.656	0.017	0.232	0.339
Leaves........	12 mo. 12 days	4.700	0.216	0.641	1.240	0.302	0.005	0.297	0.013	0.221	0.251

TABLE 8

Showing the amount of inorganic constituents in 100 parts dry matter of Negros Purple at different ages

PORTION OF STALK	AGE IN MONTHS	SiO_2	P_2O_5	Na_2O	K_2O	Fe_2O_3 Al_2O_3	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3
Bottom........	9 months	2.455	0.161	0.174	0.419	0.104	0.039	0.065	0.036	0.015	0.093
Upper bottom..	9 months	1.671	0.164	0.190	0.489	0.092	0.041	0.051	0.035	0.053	0.110
Middle........	9 months	1.098	0.144	0.148	0.329	0.054	0.029	0.025	0.037	0.053	0.073
Lower top.....	9 months	1.024	0.140	0.149	0.073	0.063	0.027	0.036	0.025	0.046	0.062
Top...........	9 months	1.069	0.128	0.147	0.385	0.064	0.021	0.043	0.039	0.042	0.079
"Seeds".......	9 months	1.140	0.210	0.160	0.489	0.091	0.043	0.048	0.043	0.056	0.086
Leaves........	9 months	4.548	0.258	0.509	1.278	0.133	0.069	0.064	0.085	0.091	0.109
Bottom........	10 months	1.381	0.224	0.341	0.364	0.470	0.091	0.379	0.032	0.045	0.083
Upper bottom..	10 months	1.116	0.204	0.379	0.362	0.322	0.020	0.302	0.034	0.031	0.081
Middle........	10 months	1.073	0.222	0.479	0.510	0.268	0.010	0.258	0.017	0.027	0.083
Lower top.....	10 months	0.911	0.241	0.451	0.463	0.210	0.017	0.193	0.042	0.031	0.067
Top...........	10 months	0.982	0.239	0.576	0.424	0.208	0.012	0.196	0.046	0.043	0.092
"Seeds".......	10 months	1.527	0.351	1.130	1.138	0.674	0.014	0.660	0.091	0.204	0.354
Leaves........	10 months	2.510	0.287	0.269	0.174		0.024		0.119	0.065	0.118
Bottom........	12 mo. 13 days	1.602	0.369	0.469	0.427	0.406	0.026	0.380	0.046	0.062	0.185
Upper bottom..	12 mo. 13 days	2.033	0.338	0.684	0.609	0.328	0.015	0.313	0.082	0.054	0.166
Middle........	12 mo. 13 days	1.520	0.258	0.397	0.339	0.251	0.007	0.244	0.029	0.041	0.151
Lower top.....	12 mo. 13 days	1.392	0.353	0.537	0.511	0.211	0.007	0.204	0.072	0.045	0.080
Top...........	12 mo. 13 days	1.468	0.267	0.520	0.480	0.205	0.015	0.190	0.079	0.087	0.088
"Seeds".......	12 mo. 13 days	1.635	0.304	0.490	0.473	0.241	0.015	0.126	0.041	0.058	0.235
Leaves........	12 mo. 13 days	10.920	0.500	1.760	1.768	1.066	0.058	1.008	0.198		0.441

EXCHANGE NOTES

Preparation for farming:

"I would work on a farm for a year between high school and college not on just any farm but on a good farm where the owner or manager is likely to teach the right way to handle the practical farm tasks. If I were a farm boy I would spend that year on a farm in another community. Then I would go straight through the 4-year agricultural course, taking a good range of foundation scientific studies. I would not try to take all the applied courses from bee keeping to market gardening. If one obtains a good foundation of the basic subjects, majors in dairy cattle production, and then gets out in the world and lands on a farm where poultry furnishes the best opportunity he can make the change.

"My point is that I would not try to prepare for any eventuality by taking a little of everything in college. I would take all the work in farm management that the college offered, also as much marketing as possible. During the summer vacations I would work on good farms, a different kind of a farm each year.

"I would ask the professors, extension specialists, and county agents where they thought the best farms for me to get experience could be found.

"Following graduation, I would work at least a year, perhaps 2 or 3 years on a good farm in the community I desire to locate".

—*Quarterly of Alpha Zeta* (February, 1931).

Children, the California Dairy Council officials decided, would take a greater interest in milk and dairy products if they understood the details of milk production. A large number of the city children, they realized, had never seen a cow. . . .

So they send a truck to make the round of the (Los Angeles) public schools, where a demonstrator gives a short lecture on the dairy cow and her uses, and where the children are given the opportunity of seeing a real cow and a real calf. As a special demonstration, a batch of butter is made in a glass stomper churn, so the children may see the various changes which take place in cream as it evolves into butter. School authorities have in preparation a program of follow-up study of the cow and her product which will occupy several weeks or months.

During the first two weeks 52 schools were visited; 110 talks were given to about 31,665 children, including children from kindergarten to the sixth grades.

—*Concentrated Milk Industries*, March, 1931.

Early in 1930, we are informed, Mr. William A. Hall, a well-known American paper-making and chemical engineer, patented a process for impregnating a special paper with the usual fertilizers, viz., potash, phosphoric acid and sulphate of ammonia, and at the same time rendering the paper capable of resisting all weather conditions during the growing period by means of a "dope" consisting of non-mineral substances, of which one is a powerful insecticide. The paper is sufficiently absorbent to hold rain precipitation or water, which slowly finds its way into the ground, carrying the fertilizers with it, and the whole decomposes, adding humus to the soil and rendering the application of additional fertilizers to a large extent unnecessary.

This mulch paper, to which the name of "Hallna" has been given, adds to the proved benefits following the use of asphalted papers (so popular in the United States) several other advantages, one being that it can be worked into the soil at the end of the growing season, whereas mulch papers waterproofed with asphalt, or other mineral substance, must be removed, since, when not actually deleterious, they possess no fertilizing value.

All mulch papers offer a protective covering to the ground, which stifles weeds, and by conserving the heat of the sun during the night time, and preventing its loss by radiation, ensures earlier, better and more prolific crops, but Hallna is in effect also a vehicle for the more effective and economical distribution of chemical fertilizers, for by its use the latter are applied direct to the plant roots, and without loss by being blown or washed away, while none are wasted on the stimulation of weed growth, since the latter is non-existent under mulch paper. In this way, the fertilizers benefit only those crops to which they are applied, and a considerable economy in their use is thus effected.

—*Tropical Life,* March, 1931.

The Fourth World's Poultry Congress was held at the Crystal Palace, London, from July 22nd, to 30th, 1930, and was attended by over sixty delegates. . . . In conjunction with the congress was held an international exhibition of poultry, pigeons and rabbits. Upwards of 7,000 head of poultry were on view from all parts of the world. The British exhibits were the most numerous, although 1,500 birds were sent from the American continent. . . .

The appliances exhibited in the trade section were very comprehensive. Amongst the exhibits were mammoth incubators, in which each separate machine will hold 16,000 eggs, which are heated and ventilated by machinery. . . .

—*The Malayan Agricultural Journal,* March, 1931.

COLLEGE AND ALUMNI NOTES

Dr. Herman Knoche of San José, California, visited the Campus recently. Doctor Knoche is a botanist with his private laboratory in San Jose. He and Dean Copeland were classmates at Leland Stanford Jr. University.

Dr. N. B. Mendiola of the College of Agriculture at Los Baños has been requested by Dr. T. S. Venkatraman of India to serve on the Committee on "Varieties, including Selection and Propagation" for the 1932 Convention of the International Society of Sugar Cane Technologists. Doctor Mendiola is now preparing a paper which he expects to send to the convention; the article is entitled: "Possibilities in the Use of Seedlings of Wild Saccharum in Sugar-Cane Improvement."

Dr. F. O. Santos, Professor and Head, Department of Agricultural Chemistry, was elected fellow of the American Association for the Advancement of Science at the annual meeting December, 1930, in Cleveland, Ohio.

Dr. Miguel Manresa spent about nine days in the first part of April in Odiongan, Romblon, as the guest of the Romblon Live Stock Association. During his stay in Odiongan he gave two talks to the live stock owners at Tablas, Romblon, on cattle improvement and management of live stock. He also demonstrated the use of a new method of castration of cattle, carabaos and horses by the use of Burdizzo pincers. In addition to these professional talks Doctor Manresa gave an address at the Commencement Exercises of the Odiongan Rural High School on March 31.

Dr. Robert L. Pendleton, head, Department of Soils, has been granted a year's leave of absence from the University of the Philippines. He left May 9 for Peiping, China, where he is temporarily employed by the National Geological Survey of China to establish a soil survey for that country, and to train a staff for the development of the soil survey.

Dr. F. O. Santos gave a series of three lectures in the U. P. Summer School at Baguio in April, 1931. The following were the subjects of the lectures:

1. What shall we eat?
2. Nutritive values of some common Philippine food materials.
3. Problems in Filipino Nutrition.

Professor Inocencio Elayda of Department of Soils spent the month of May on a second trip to Mindanao as one of the University of the Philippines committee for the selection of a suitable tract of public land as reserve for the University of the Philippines. During February he was in Palawan with the Director of Prisons to make a special study of the agricultural conditions in the Iwahig Penal Colony. During March and the first part of April, Professor Elayda was in Mindanao first in connection with the selection of a site for a new penal colony in the Davao region, and later was deputed to assist in the first trip of the University of the Philippines land selection committee.

The College of Agriculture has been requested by Dr. H. Wenholz, Director of Plant Breeding of the Department of Agriculture, New South Wales, to coöperate with him in sugar-cane breeding. In the coming cane fruiting season, this College expects to send Doctor Wenholz, seed of certain crosses which he desires made for him.

A similar request was received last year from Dr. A. J. Mangelsdorf of the H. S. P. A. Experiment Station and seed was sent to him some time ago, but unfortunately the material was refused entrance in Hawaii.

Samples of a wild *Saccharum* which might turn out to be a good stock for sugar-cane hybridization work were received on March 13 and April 21, 1931 from Director Fischer of the Bureau of Forestry who discovered the species in Bukidnon. This wild cane is not much different in certain respects from some seedlings of talahib and local kassoers. A number of plants of the Bukidnon wild cane are now growing vigorously in the College cane nursery.

A letter from Doctor Trelease to Professor Yule tells that Dr. E. D. Merrill is now Director of the New York Botanical Garden. Doctor Trelease, now head of Department of Botany in Columbia University, writes: "We have cooperative arrangements with the Garden. Doctor Merrill is on our faculty, and three of us from Columbia are on the board of scientific directors of the Garden. It seems rather odd, doesn't it, for Merrill, McLean, and me all to be with the same outfit here". Life certainly did give its kaleidoscope an interesting turn, for it is not so many years since all these three botanists were associated in the Philippines, Merrill as Director of Bureau of Science and Trelease and McLean in our College.

Geronimo Pascua, B. Agr. '30, now teaching in Bukidnon Agricultural School in a letter to Assistant Professor Cole gives an interesting description of that school and his experiences. We quote in part:

"I never thought that a teacher's task was so difficult and required so much energy.—During the past months I have realized that experience is really the greatest teacher in life. It increases materially the efficiency in any line of human endeavor. For this reason I take off my hat and bow my head to the experienced teacher.....

"Now, let me tell you something about the Bukidnon Agricultural School. The school covers an area of over 700 hectares. It has nine teachers and about 150 students in all, seventh grade to fourth year high school. Mr. Felicisimo Obias, my former classmate in English under you, is the acting Principal. He is a practical man, you know, judging from his administration here. The school is famous for having a great number of cattle and carabaos, about 240 in all. The school has also horse, poultry and swine projects. It is a good training ground for students in Animal Husbandry because of having enough material for instruction, but they need a good and experienced animal husbandman. I am yet green in the work but I am trying my best to let my students drink knowledge and training from a flowing stream and not from an stagnant pool. To accomplish my aim, I had and have to dig up numerous references, practise in the School Ranch, get in contact with the experienced cattle owners in Bukidnon and ask for information and help from authorities regarding my problems and work. I have to give the fullest measure of devotion to my task. I have learned many valuable things which I never learned nor came across in college pertaining to practical and real animal husbandry work. Training wild steers is an example. . . .

In Bukidnon Agricultural School, there is not a single girl. It is about 19 km. from Malaybalay, the capital. Transportation and market facilities here are very inadequate. The school is accessible to trucks during the dry season but trucks are insignificant in number. Horses and carabaos are the commonest means of transportation. We really need economic development in Mindanao." . . .

Mr. Pascua sent for his English long themes to use as guides in the written work he requires in his animal husbandry class. Would that others would follow his example!

On the evening of March 7 in the College Auditorium the Varsity Sweater and Letters, College Letters, trophies, medals and ribbons for the year 1930–31 were awarded. It was a genuine College athletic evening.

Everything was well planned. The main body of Auditorium was filled with classes seated in order with their banners and pennants. The audience sat on the edges as was proper. The singing and yells were given with a vim that sent the blood tingling and sped faculty memories to other days and other scenes.

The program follows:

PART I

Announcer	Chairman of Board of Athletic Control
1. Song—U. P. Band	Audience
2. Intramural Hurdles	Winners in Intramural Tournament
Carnival Relays	Sophs C. A.
Basket Ball	Freshies C. A.
Track and Field	Sophs C. A.
Tennis	Juniors C. A.
Football	Forest School

(Broadcasted from Stage)

3. Song—"Wahoo" The General Winners of the Intramural Tournament	Juniors

4. Long Distance Word Medley Relay
   (N. C. A. A., Record time 3 minutes 35.1 seconds)
      Dean Gregorio San Agustin
      Prof. D. Soriano
      Dean B. M. Gonzalez
5. Song—"How Does It Feel"................................College Letter Men
6. Song—"Letter Men All"..................................U. P. Letter Men
7. 1,500 Meter Word Run..........................Prof. Cándido C. Bartolomé
   (Referee, N. C. A. A., Record time 4 minutes 15.9 seconds)
8. Championship Bout—U. P. Manila *vs.* Los Baños
      (6 rounds—Broadcasted)
         Volley Ball
         Carnival Relays
         Track and Field
         Football
         Boxing
9. Song—"Goodbye Manila, Goodbye"..................................Audience

PART II

Distribution of Awards

PART III

Movie—1930 Olympic Games Held in Tokyo

Mr. Nicolas Machan, the director of physical education in the Los Baños Colleges, deserves much praise for the care and thought given to the planning of the program. And he desires to give here much credit to Miss Anne Cole for suggestions and assistance in arranging for the evening. The broadcasting—with Calo Bedelles at the megaphone (well concealed)—short wave—Station DEFEAT—was a great success. Singularly free from static.

The following cups were won by the Los Baños Associated Colleges—All are handsome silver trophies.

1. For basket ball—Cup given by Hon. Antonio de las Alas, Speaker *pro tem* House of Representatives.
2. For volley ball—Cup given by C. Alkan and Company.
3. Soccer Football—Cup given by Roces and Company.
4. Tennis—Cup given by Hon. Jorge B. Vargas, Under Secretary of Department of Agriculture and Natural Resources.
5. Carnival Relays and Track and Field—Cup given by Hon. Alexander Reyes, Solicitor General, Bureau of Justice.

6. Winner Intramural General Championship—Cup given by Hon. Rafael Alunan, Secretary of the Department of Agriculture and Natural Resources.

U. P. LOS BAÑOS INTRAMURAL LEAGUES

1930–1931

By collecting 42 points the Juniors, C. A. '32 won the Intramural general championships defeating the other six participating units in the most interesting and keenest competition throughout the whole 1930-1931 athletic leagues.

Following is the result of the 1930-1931 Intramural Leagues held on the U. P. Los Baños Athletic Field.

(C. A. = College of Agriculture; C. V. S. = College of Veterinary Science; F. S. = Forest School.

Unit	Basket ball	Foot-ball	Tennis	Relays	Track Field	Volley ball	Total point
C. A. '32 (Juniors)	6	8	10	6	6	6	42
C. A. '33 (Sophomores)	4	8	4	10	10	4	40
C. A. '34 (Freshmen)	10	4	6	2	2	2	26
F. S.	0	0	0	4	4	10	18
C. V. S.	2	0	2	0	0	0	4
C. A. '31 (Seniors)	0	2	0	0	0	0	2
C. A. (Rural High School)	0	0	0	0	0	0	0

U. P. Los Baños Intramural Carnival Relays

By piling up a total of 30 points, the Sophomores, C. A. '33, captured the first annual intramural carnival relays held on the U. P. Los Baños Athletic Field. The Juniors with a score of 26 took second honors while the Forest School and the Freshmen teams tied for third.

The following is the result of the U. P. Los Baños Intramural relay carnival:

First place	C. A. '33 (Sophomores)	30 points
Second place	C. A. '32 (Juniors)	26 points
Third place	C. A. '34 (Freshmen)	22 points
	Forest School	22 points

U. P. Los Baños Intramural Track and Field

The Sophomores, C. A. '33, added one more victory to their credit by capturing the U. P. Los Baños Intramural Track and Field held on the U. P. Los Baños Athletic Field. They piled up a total of 55 points as against 32½ for the Juniors, their closest rivals.

Pedro Yatar of the Sophomores, C. A. '33, was the highest individual point winner and Amado Paggao of the Juniors, C. A. '32, was a close second. Yatar captured 28 points and Paggao held the second honor at 26½ points.

The following is the result of the U. P. Los Baños Intramural Track and Field:

First place	C. A. '33 (Sophomores)	55 points
Second place	C. A. '32 (Juniors)	32½ points
Third place	F. S.	26 points
Fourth place	C. A. '34 (Freshmen)	16 points

U. P. Los Baños Intramural Track and Field Individual Highest Point Winners

First	Pedro Yatar (C. A. '33, Sophomore)	28 points
Second	Amado Paggao (C. A. '32, Junior)	26½ points
Third	Guillermo Manalo (C. A. '34, Freshman)	12 points
Fourth	Pedro Lorenzo (C. A. '33, Sophomore)	11 points

U. P. Intramural Relay Carnival at Manila

Unit IV composed of the Associated Colleges at Los Baños won the U. P. inter-unit track-relay championships in a contest held on Wallace Field, Manila. The Los Baños athletes were at their best, winning all the events by wide margins. The "Aggies" collected a total of 40 points. Unit II which was picked to give the "Aggies" a close fight for the honors landed a poor third place while Unit III took the runner-up position. The events won by the Los Baños athletes were 400 meter relay, long distance relay, sprint medley relay, and the 1,600 meter relay.

Result of the U. P. Intramural Carnival Relays held at Manila are as follows:

First	Unit IV	40 points
Second	Unit III	16 points
Third	Unit II	12 points
Fourth	Unit I	2 points

U. P. Intramural Track and Field Meet Held at Manila

By piling up a total of 90½ points, Unit IV, representing the College of Agriculture captured the U. P. Intramural Track and Field championship. Unit III took second place with 29¼ points, with Unit II coming in third with 28½ points, and Unit I last with 4, The "Aggies" won ten first places.

The following is the result of the U. P. Intramural Track and Field meet held at Manila:

First	Unit IV	91½ points
Second	Unit III	29¼ points
Third	Unit II	28½ points
Fourth	Unit I	4 points

Following were the highest individual point winners during the U. P. Intramural Track. and Field Meet held at Manila, 1930-1931:

First	Pedro Yatar (Unit IV)	20 points
Second	Amado Paggao (Unit IV)	15 points
Third	Guillermo Manalo (Unit IV)	10 points

The awards follow:

Winners of the U. P. Los Baños Intramural League

Volley ball	F. S.
Winner general championship	C. A. '32 (Juniors)
Tennis	C. A. '32 (Juniors)
Soccer football	C. A. '33 (Sophomores)
Carnival relays and track and field	C. A. '33 (Sophomores)
Basket ball	C. A. '34 (Freshmen)

Individual Highest Point Winners

Pedro Y. Yatar	C. A. '33 (Sophomore)
Amado B. Paggao	C. A. '32 (Junior)
Guillermo R. Manalo	C. A. '34 (Freshman)

VARSITY SWEATER MEN

Track and Field

Pedro Y. Yatar	C. A. '33 (Sophomore)
Amado B. Paggao	C. A. '32 (Junior)

Basket ball

Briccio Reynoso	C. A. '32 (Junior)

Baseball

Perfecto Ocampo	C. A. '33 (Sophomore)

VARSITY LETTER MEN

Major Sports

Baseball:

1. Gregorio Santos	F. S.
2. Moisés Angel	C. A. (Junior)
3. Perfecto Ocampo	C. A. (Sophomore)

Track and Field:

1.	Amado Paggao	C. A. (Junior)
2.	Pedro Yatar	C. A. (Sophomore)
3.	Pedro Lorenzo	C. A. (Sophomore)
4.	Eleuterio Enriquez	C. A. (Sophomore)
5.	Guillermo Manalo	C. A. (Freshman)
6.	Pedro Cagalawan	F. S.
7.	Florentino Fontanilla	F. S.

Basket ball:

Briccio Reynoso	C. A. (Junior)

Football:

Charas Suebsaeng	C. V. S.

Minor Sports

Volley ball:

Felicísimo Maceda	C. A. (Sophomore)

Boxing:

1.	Vicente Hermoso	C. V. S.
2.	Gil Pabillo	C. V. S.
3.	Adolfo Castillo	C. A. (Sophomore)

Tennis:

José Utzurrum	C. A. (Junior)

Basket ball midget:

Alberto Elefaño	C. A. (Sophomore)

COLLEGE LETTER MEN

C.A. (A); C.V.S. (V); F.S. (F)

1.	Briccio Reynoso	C. A. (Junior)	Basket ball
2.	Alberto Elifanio	C. A. (Sophomore)	Basket ball and Volley ball
3.	Cornelio Lemoncito	C. A. (Graduated in October)	Basket ball
4.	Charas Suebsaeng	C. V. S.	Football and Tennis
5.	Thonghaya Punyasingha	C. A. (Sophomore)	Football
6.	José Saddul	C. A. (Junior)	Football
7.	Sawat Veradeja	C. A. (Junior)	Football and Tennis
8.	José Utzurrum	C. A. (Junior)	Football, Tennis, and Track and Field
9.	Phanom Smitananda	C. A. (Sophomore)	Football
10.	Felix Madrid	C. A. (Sophomore)	Football
11.	Phisit Sukavanija	C. A. (Sophomore)	Football
12.	Thuan Kom Kris	C. A. (Sophomore)	Football
13.	José Luna	C. A. (Senior)	Football
14.	Elías Sombito	C. A. (Junior)	Football
15.	Avelino Bigornia	C. A. (Freshman)	Football
16.	Basunie Saropie	C. A. (Sophomore)	Football
17.	Sakvin Tulalamba	C. A. (Sophomore)	Football
18.	Felicísimo Maceda	C. A. (Sophomore)	Volley ball
19.	Felix Arriola	C. A. (Sophomore)	Volley ball
20.	Federico Banaban	F. S.	Volley ball and Track and Field
21.	Raul de Arana	C. A. (Junior)	Volley ball
22.	Felino Eustakio	C. A. (Freshman)	Volley ball
23.	Guillermo Manalo	C. A. (Freshman)	Volley ball and Track and Field

24. Moisés Angel	C. A. (Sophomore)	Volley ball and Baseball
25. Hermogenes Gilbero	C.A. (Rural High)	Volley ball
26. Agaton de la Cruz	C. A. (Sophomore)	Volley ball
27. Felipe Crisostomo	C. A. (Sophomore)	Volley ball
28. Santiago Banilan	C. A. (Junior)	Volley ball
29. Perfecto Ocampo	C. A. (Junior)	Baseball
30. Adolfo Castillo	C. A. (Sophomore)	Baseball and Boxing
31. Máximo Cañeda	C. A. (Freshman)	Baseball
32. Claudio Adam	C. A. (Freshman)	Baseball
33. Anselmo Guillen	C. A. (Sophomore)	Baseball
34. Gregorio Santos	F. S.	Baseball
35. Gregorio Salinas	F. S.	Baseball
36. Laureano Labasay	F. S.	Baseball
37. Ceferino Magno	C. A. (Junior)	Tennis and Track and Field
38. Fernando Remedios	C. A. (Freshman)	Boxing
39. Francisco Sevilleno	C. A. (Junior)	Boxing
40. Vicente Hermoso	C. V. S.	Boxing
41. Gil Fabillo	C. V. S.	Boxing
42. Pedro Yatar	C. A. (Sophomore)	Track and Field
43. Pedro Lorenzo	C. A. (Sophomore)	Track and Field
44. Amado Paggao	C. A. (Junior)	Track and Field
45. Eleuterio Enriquez	C. A. (Sophomore)	Track and Field
46. Filemon Ampug	C. A. (Junior)	Track and Field
47. Florentino Dumaguing	C. A. (Freshman)	Track and Field
48. Irineo Gadiano	C. A. (Sophomore)	Boxing
49. Domingo Gapuz	C. V. S.	Track and Field
50. Pedro Cagalawan	F. S.	Track and Field
51. Florentino Fontanilla	F. S.	Track and Field

MEDALS AWARDED

N. C. A. A. (National Collegiate Athletic Association)

Carnival Relays

1,600-Meter Relay:

First place—

1. Pedro Cagalawan	F. S.
2. Pedro Lorenzo	C. A.
3. Amado Paggao	C. A.
4. Pedro Yatar	C. A.

Long Distance Medley Relay:

First place—

1. Pedro Cagalawan	F. S.
2. Pedro Lorenzo	C. A.
3. Eleuterio Enriquez	C. A.
4. Pedro Yatar	C. A.

Track and Field

400-meter low hurdles:

Second place	Amado Paggao	C. A.

1,500-meter run:

1. Pedro Yatar	C. A.
2. Pedro Lorenzo	C. A.
3. Eleuterio Enriquez	C. A.
4. Pedro Cagalawan	F. S.

Discus throw:

First place	Guillermo Manalo	C. A.

Running high jump:

First place	Florentino Fontanilla	F. S.

Running high jump:
  Second place....................Domingo Gapuz......................C. V. S.
400-meter run:
  Third place....................Pedro Yatar......................C. A.
  Fourth place....................Amado Paggao......................C. A.
Shot put:
  Fourth place....................Guillermo Manalo......................C. A.
800-meter run:
  1. Pedro Yatar......................C. A.
  2. Pedro Lorenzo......................C. A.
  3. Pedro Cagalawan......................F. S.
1,600-meter Relay:
  1. Pedro Cagalawan......................F. S.
  2. Pedro Yatar......................C. A.

P. A. A. F. (Philippine Amateur Athletic Federation)

800-Meter Run:
  First place....................Pedro Yatar......................C. A.
1,500-Meter Run:
  1. Pedro Yatar......................C. A.
  2. Pedro Lorenzo......................C. A.
400-Meter Hurdles:
  Third place....................Amado Paggao......................C. A.

Charity Fair Tournament Manila (Special Boxing Tournament)

Adolfo Castillo......................C. A.
Vicente Hermoso......................C. V. S.

U. P. INTER-SECTION GAMES

U. P. Manila vs. U. P. Los Baños

1. Basket ball—Results, tie—Captain, Reynoso Briccio.
2. Boxing—Winner, U. P. Los Baños—Captain, Adolfo Castillo.
3. Baseball—Winner, U. P. Manila—Captain, C. Gaviola
4. Carnival Relays—Winner, U. P. Los Baños—Captain, Pedro Yatar.
5. Track and Field—Winner, U. P. Los Baños—Captain, Pedro Yatar.
6. Tennis—Winner, U. P. Manila—Captain, Lope Engayo.
7. Volley ball—Winner, U. P. Los Baños—Captain, Felicísimo Maceda.
8. Football—Winner, U. P. Los Baños—Captain, Charas Suebsaeng.

SAVE THE ABACÁ INDUSTRY FROM RUIN BY BUNCHY-TOP[1]

Abacá, a plant native of the Philippines, is the source of a material known in commerce as Manila hemp which is one of our most important exports. Formerly, the Philippines had a monopoly of the Manila hemp industry, but recently abacá has been introduced into other tropical countries, and some of them are now producing the fiber for export. But our abacá growers should not worry about the lost monopoly. What they should worry about is the threat of bunchy-top which is far more dangerous than all foreign competition. The Philippines can still lead in Manila hemp exports if the present acreage of abacá is only maintained, and bunchy-top controlled and prevented from spreading to the major abacá provinces.

Bunchy-top is the most destructive disease of abacá known, and is considered to be a malady of the virus type, the transmissibility of which is restricted to an insect vector. The disease attacks both abacá and banana. It can be kept from completely destroying the abacá industry of the Philippines by preventing its being spread from locality to locality, especially to the important abacá provinces. This can be done by prohibiting the movement from the infected areas to other abacá centers of all plants of abacá, banana and their relatives or parts of them, with the exception of the clean fiber of abacá, banana, canton and pacol.

Also care must be taken to prevent the spread of the aphid *Pentalonia nigronervosa* Coq. as it has been shown by Dr. E. J. Goddard of Queensland University in Australia, and by the writer in the Philippines that bunchy-top is transmitted from plant to plant by this aphid, or plant louse and thus far only abacá, banana and their close relatives have been found to be hosts of this aphid. Hence it is most important to prohibit the moving from locality to locality not only of suckers and corms of abacá, banana, and their close relatives but also of soil taken from abacá or banana fields. The use of leaf sheaths of banana and leaves of abacá and banana for wrapping propagative plant materials and perishable products for shipment from the bunchy-top-infected regions to the important abacá growing districts is extremely dangerous. For infected aphids may be carried on the corms, on or between the leaf sheaths, within the intercellular spaces at the cut ends of the petioles and leaf sheaths, on leaves of living plants and with the soil containing portions of roots and corms of abacá. Experience at the College of Agriculture since 1925 has shown that in dry weather and immediately after heavy rains the aphids may be found on the

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[1] General contribution from College of Agriculture No. 293.

THE PHILIPPINE AGRICULTURIST, VOL. XX, NO. 3, AUGUST, 1931.

corms, among the roots, at the bases of plants, between leaf sheaths and in the intercellular spaces at the cut ends of the petioles and leaf sheaths.

If bunchy-top breaks out in the more important abacá provinces, entire stools of abacá which show symptoms of the disease should, when detected, be dug up immediately, chopped to pieces *in situ* and sprayed thoroughly with black leaf 40 or tobacco decoction to kill the infected aphids. The corm should be burned to prevent production of diseased sprouts. In spraying, care should be taken to include the soil around the stools. For destroying *Pentalonia nigronervosa* the writer in his experiments used about one cc. of the commercial black leaf 40 in 1,500 cc. of tap water in which about five grams of laundry soap had been dissolved. Tobacco decoction may be prepared by steeping 500 grams of tobacco stems or factory refuse in 8 to 12 liters of water. Spraying may be done with the use of a Flit pump. As a means of saving the whole plantation, this measure is recommended in a locality where the disease has just appeared. The same measure is recommended in new plantings in the totally devastated fields of Laguna and Cavite provinces.

The abacá industry in the completely devastated areas may be revived if every particle of all diseased abacá and banana plants is removed and no abacá, banana, or their close relatives be planted on the land for nine to twelve months. After this period of rest the vacated places may be replanted with healthy suckers. The plants to be used in the reëstablishment of the abacá industry should be started either from seeds or the suckers obtained from districts absolutely free from bunchy-top. Abacá grown from seed requires a longer period to reach maturity and productiveness than abacá produced from suckers. The seeds, however, are easier to transport and handle than the suckers and they eliminate all chances of obtaining plants with latent stages of bunchy-top, or the introduction of infected aphids. In either case, during the first few months, the young plantings should be carefully inspected at intervals of 30 to 40 days. Any bunchy-top case found during an inspection should be dug up, chopped to pieces *in situ* and sprayed thoroughly with tobacco decoction. The effectiveness of the bunchy-top eradication work will depend upon one's ability to diagnose accurately the early symptoms of bunchy-top of abacá. A detailed description of the symptoms of the disease in the early and advanced stages is given by the writer in *American Journal of Botany*, volume 17, pages 1 to 18, 1930. All aphid-infested abacá plants and the ground immediately about them should be sprayed with tobacco decoction and watched suspiciously.

Occasional infection of replaced abacá plants is due to our inability to detect the presence of the aphid, or plant louse which carries the infectious material from diseased to healthy abacá plants. In our work at the College of Agriculture we have shown that if all diseased plants are wholly removed leaving not a scrap of the plant and the land allowed sufficient rest all of the aphids which have fed on diseased abacá will have matured and died. The infectious material of bunchy-top is drawn from the plant by the aphid with the sap of the abacá on which it feeds. Hitherto, however, experience at the College of Agriculture has shown that this infectious material is not transmitted to the young which are born of the infected adult aphids. With this knowledge there is considerable assurance that as soon as the infected parent aphids are dead there is no fear from their young unless they become infected. The only source of infectious material for the young aphids are diseased abacá, banana and their relatives.

Whether varieties of abacá highly resistant to the disease may be developed eventually is not known. Results of our work at Los Baños to date have shown that all varieties of abacá used, including first generation variety hybrids, are infected by bunchy-top in the same degree. There seems very little hope that resistant forms will be developed. Crossing with wild species might give resistant forms but there is danger that this may reduce the quality of the fiber.

G. O. Ocfemia
Of the Department of Plant Pathology

DISEASES OF CULTIVATED GINGER[1]

F. L. STEVENS AND JUAN D. ATIENZA
Of the Department of Plant Pathology

WITH FOUR TEXT FIGURES

LEAF SPOT

A leaf spot on cultivated ginger (*Zingiber officinale* Rosc.) is very prevalent in the region of Los Baños and in many other parts of the Philippine Islands. The infestation is so severe that often half of the chlorophyll area of a plant is destroyed with corresponding loss to the crop.

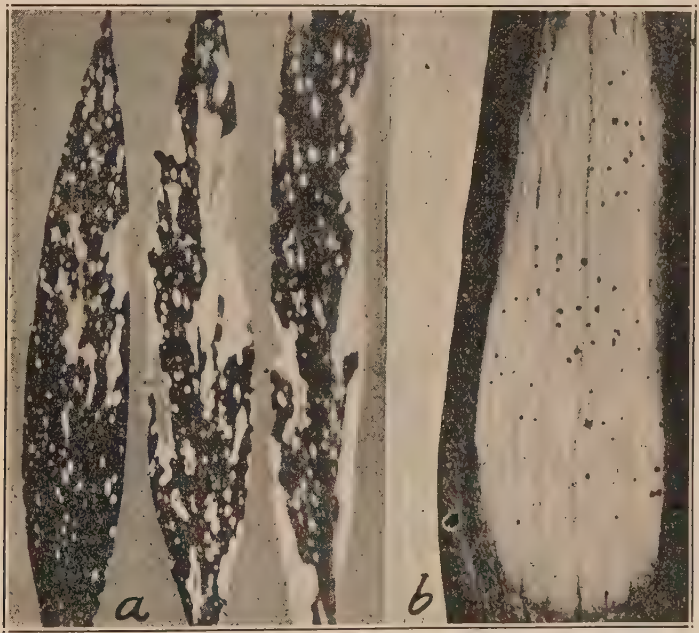

Fig. 1.—(*a*) A photograph showing leaves of ginger with spots in different degrees of development. (*b*) A single leaf spot much enlarged showing the pycnidia.

The spots when barely visible to the naked eye consist of a snow white central region, irregularly oblong, 150×225 μ, which is surrounded by a watery translucent zone 75-100 μ broad. Even at this stage the central white region bears one or two pycnidia and the mesophyll is completely consumed and the center of the region appears as a ragged hole.

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[1] Experiment Station contribution No. 732. Received for publication March 4, 1931.

As the spot enlarges these characters are maintained though the outline of the spot becomes very irregular, with the long axis of the spot lengthwise of the leaf, and the centers of the spots are very ragged and torn and bear very numerous pycnidia (fig. 1a and b). In the latest stages by coalescence of individual spots two-thirds or more of a leaf may be involved.

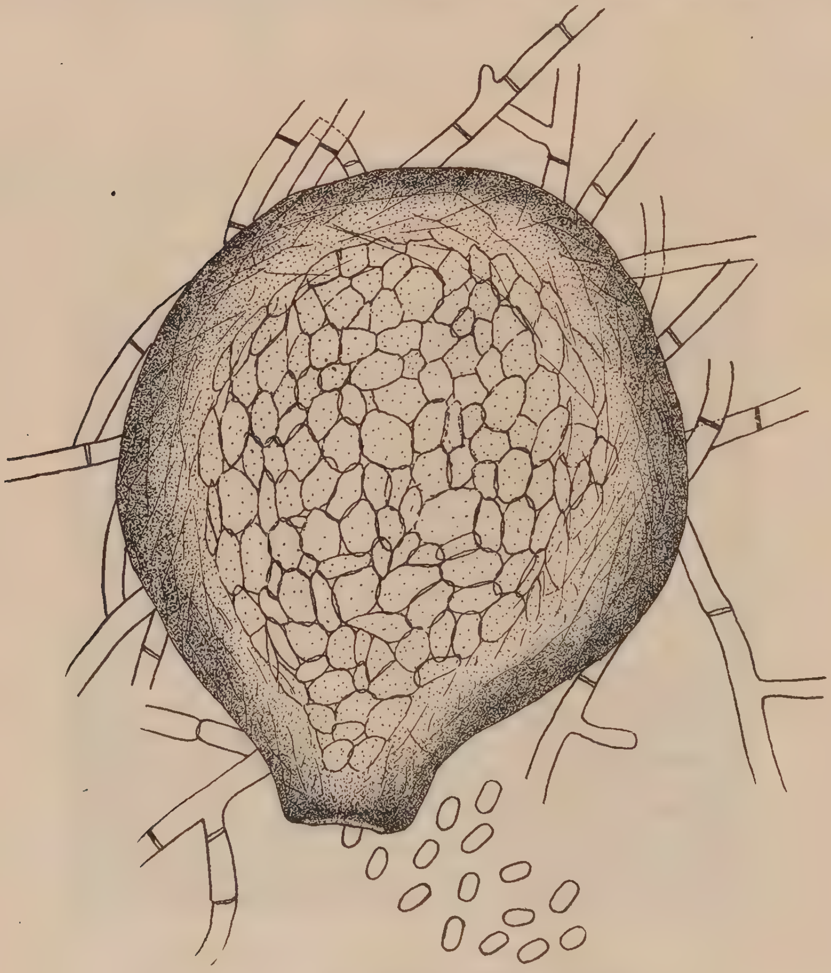

Fig. 2.—A pycnidium, mycelium and spores.

A pure culture was secured by aseptically preparing a suspension and making dilution platings from it in ginger agar (200 grams ginger boiled in 1000 cc. water, filtered and 20 grams of agar added). Single colonies that were pure were picked from these plates.

Two modes of inoculation were tried, one using impure inoculum; the other using a pure culture of the fungus. The inoculations with impure inoculum could merely determine the infective nature of the disease without demonstrating the causal agent and were made before a pure culture had been secured. They were conducted as follows: The white centers of several spots bearing very numerous pycnidia were cut out and finely teased in a few drops of sterile water using sterile utensils. An oëse of the resulting suspension bearing spores, bits of mycelium, and diseased host was placed on a marked spot on a young healthy ginger leaf. Twenty such inoculations were made. Two kinds of controls were employed. In one, twenty similar inoculations were made except that the suspension was sterilized by heat before being applied. In the other case, twenty similar inoculations were made using only sterile water.

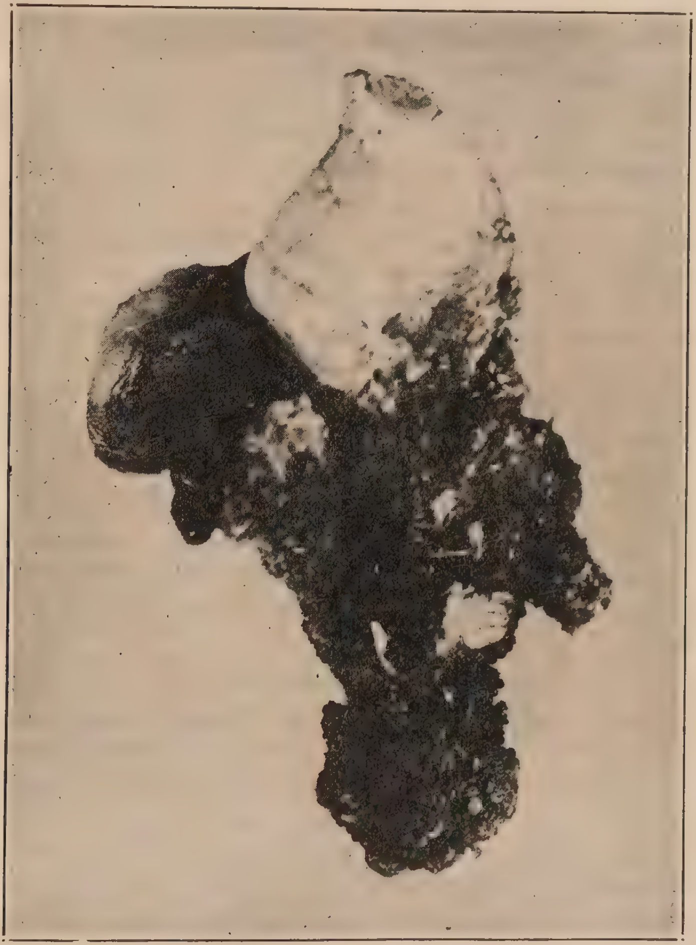

Fig. 3.—A photograph of a rhizome of ginger showing numerous perithecia of *Rosellinia* at one end and white superficial mycelium at the other.

The plants used for inoculation were rhizomes that had been dormant but that were just beginning to send forth a new crop of shoots and leaves. After inoculation the plants were kept in a moist chamber with humidity nearly at saturation.

The results of the inoculations were as follows: With impure inoculum four to seven days after inoculation on young leaves spots began to show. No spots appeared on the control plants.

Since the fungus appears to be a new species we describe it as follows:

Caniothyrium zingiberi Stevens and Atienza sp. nov.

Pycnidia amphigenous but more abundant below, circular, subglobose, dark yellow to black, reticulatious 3-4 μ, ostiole clearly defined, circular, 7 μ in diameter, concolorous on darker pycnidia, dark bordered on the paler pycnidia. Pycnidia 40-125 μ in diameter. Spores hyaline when young, light yellow when old, continuous, ovoid, 3.5-4×7-10 μ, often biguttulate (fig. 2).

Spot as described above.

On leaves of cultivated ginger, *Zingiber officinale*

Agricultural College, Laguna, P. I.

10-24-1930. Stevens No. 856.

Since only by careful search are the mature colored spores found this fungus might readily be mistaken for a *Phyllosticta*. The pycnidia when grown in agar are distinctly rostrate, the rostrom being 25 μ broad and 17 μ high.

BLACK RHIZOME ROT

A dry rot of ginger rhizomes is common, especially in those rhizomes which after harvest lie on or near the ground at the bottom of a pile.

The older portion of a rotting rhizome shows upon the surface multitudes of globose perithecia nearly two millimeters in diameter, (fig 3). The interior of the rhizome at such places is rotted away to a mere shell enclosing the vascular framework.

In younger conditions of the disease a white superficial mycelium shows superficial over the still unrotted rhizome. Cross section in such regions reveals the vascular strands heavily darkened and infected.

The fungus is a *Rosellinia* which we describe as follows:

Rosellinia zingiberi Stevens and Atienza sp. nov.

Perithecia superficial, globose, black, 1500-1800 μ in diameter, surface covered by low irregular or conical projections about 70 μ high and 120 μ of base.

Spores (fig. 4a) exclusive of the awns 60-70 μ long, 7 μ wide, continuous, multiguttulate, hyaline when young, black when old; a very slender awn at each end, about 18 μ long, 80×7 μ exclusive of the awns. 8 spores per ascus, inordinate. Asci 255×30 μ, wall very thin, hyaline, almost invisible. Paraphyses numerous, filiform, mycelioid.

On *Zingiber officinale* rhizomes

Agricultural College, Laguna, P. I.

10-5-1930, Stevens No. 878.

313 species of *Rosellinia* are reported in the Sylloge Fungorum.

This specimen shows spores much larger, almost twice as large, than the usual *Rosellinia;* even much larger than *Rosellinia gigaspora* Ell. and Ev.

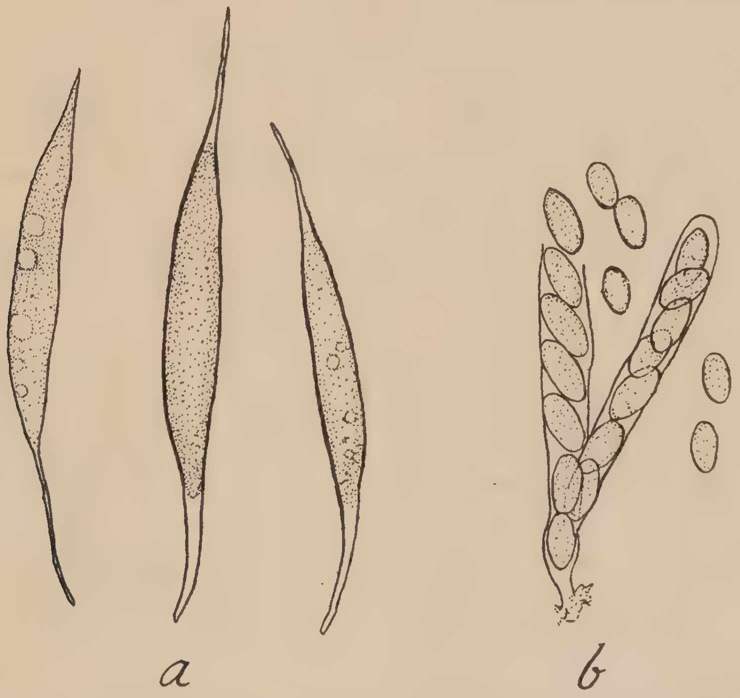

Fig. 4.—(*a*) Mature ascospores of *Rosellinia zingiberi* Stevens and Atienza. (*b*) Asci and ascospores of *Nectriella zingiberi* Stevens and Atienza.

though smaller than *R. macrosperma* Speg. Besides the spore size this species is also definitely set apart from other species by the two awns.

It is separated from *R. emergens* (B. and Br.) Sacc. var. *bambusicola* Theiss. by the larger size of the perithecia, and by the shape and thickness of the spores.

RED RHIZOME ROT

A second dry rhizome rot occurs in much the same condition as the one described above but is readily differentiated by the presence of numerous superficial bright red perithecia which occur in spots often 2 cm. in diameter.

The perithecia are strictly superficial and the mycelium and resulting rot does not extend deeply into the rhizome, usually not more than 3 or 4 mm.

The causal fungus is a *Nectriella* which we describe as follows:

Nectriella zingiberi Stevens and Atienza sp. nov.

Perithecia strictly superficial occurring in groups from 2 to 20 mm. in diameter and consisting of very numerous individual perithecia, but each perithecium distinct from its neighbors. Perithecia globose bright red, even when young, surface rough with irregular warts, diameter 210-240 μ. Ostiole irregularly circular up to 90 μ across, somewhat rostrate. Mycelium red. Asci (fig. 4b) very thin walled, almost invisible, about 70×7-10 μ. Paraphyses none.

Spores (fig. 4b) inordinate, hyaline, oblong, 1-celled, 10-11×4 μ.
On rhizomes of cultivated ginger, *Zingiber officinale*
Agricultural College, Laguna, P. I.
11-18-1930, Stevens No. 1126.

Of frequent occurrence on ginger rhizomes is a second *Nectriella* which agrees in spore, ascus, and perithecium size with the species described above but which differs from it in two very striking ways:

1. The perithecia remain colorless or with barely the faintest pink tinge.
2. The perithecia occur in dense clumps, hundreds of them crowded together in close contact.

Since this form deviates from *N. zingiberi* in these two details only, we describe it as a variety as follows:

Nectriella zingiberi Stevens and Atienza var. *pallida* Stevens and Atienza, n. var.

This differs from the type in having perithecia in dense clusters and in lacking the red color of the type.
On rhizomes of *Zingiber officinale*
Agricultural College, Laguna, P. I.
11-18, 1930, Stevens No. 1128.

The Zingiberaceae seem to be singularly and exceptionally free of fungi. In the twenty-four volumes of Saccardo's Sylloge Fungorum only two fungi, *Saccharomyces lindneri* and *Mycoderma chevalieri* are recorded on *Zingiber officinale;* on *Z. adans, Hypocrella discoidea;* on *Z. miogae, Sphaerella zingiberi;* on *Z.* sp. ind. a *Hypocrella* and a *Gibberidea* and on Zingiberaceae indet. a *Micropeltis*, a *Hypocrella*, an *Aleurina*, and a *Pythium*.

MORPHOLOGICAL STUDY OF THE FLOWER OF MONOCHORIA VAGINALIS (BURM. f.) PRESL[1]

JOSÉ B. JULIANO
Of the Department of Plant Physiology

WITH TWO PLATES

This weed, *Monochoria vaginalis* (Burm. f.) Presl, locally known as *Biga-bigáan, Gabing-uák,* and *Baga-uák,* is a subaquatic herbaceous plant, inhabiting shallow stagnant waters and open wet places. It grows also in zacate (*Leersia hexandra* Sw.) and rice (*Oryza sativa* Linn.) fields. According to Merrill (1923-1925), it is found throughout the Philippines at low and medium altitudes, and in tropical and subtropical Asia to Malaya. This plant flowers all the year round. Because of its abundance and gregarious flowering habit, this weed is handy material for morphological study.

The first contribution to the life history of the Pontederiaceae was by Smith (1898), who published a rather full account of the seed development in *Eichornia crassipes* and *Pontederia cordata,* and gave a figure of the megagametophyte of *Heteranthera graminis.* Coker (1907) described the development of the megagametophytes and endosperm in *Pontederia cordata* and *Heteranthera limosum,* and his findings in *Pontederia* were later confirmed by Smith (1908). So far as the writer knows, nothing has ever been published on the morphology of the gametophyte or on the development of the endosperm and seed of *Monochoria.*

The present study deals with the development of the flower, and the morphology of the gametophytes, endosperm, and seed of *Monochoria vaginalis* (Burm. f.) Presl. Merrill (1912) states that the Pontederiaceae includes only five genera, and that three genera; namely, *Eichornia, Pontederia* and *Heteranthera,* have already been worked out. The present paper is intended to complete so far as possible our knowledge on the morphology of the Pontederiaceae. While there may be nothing novel reported in this paper, the knowledge presented should be of real help in the phyllogenetic treatment of the family.

MATERIALS AND METHODS

The material used in this study was gathered at frequent intervals from plants growing in the zacate fields at Bay, Laguna, from October 15 to November 30, 1930. Formalin-acetic-alcohol prepared according to the

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[1] Experiment Station contribution No. 733. Received for publication March 24, 1931.

formula given by Chamberlain (1924) was employed as fixative and killing agent. The material was embedded in the usual fashion and sections were cut five to ten microns in thickness. The preparations were stained mostly in Haidenhain's iron-Haematoxylin and counterstained with aniline orange gold dissolved in clove oil.

THE FLOWER

The racemose inflorescence enclosed by a thin membranous sheathing bract arises from the sheath of the uppermost leaf and measures from about three to six centimeters in length; it bears a few flowers which are pedicillate. The individual flower, which attains a size of about a centimeter in length, is perfect, and bears a perianth of five lobes, bluish and persisting even after fertilization. Within the perianth segments are located a single whorl of six stamens, which are inserted at the base of the perianth lobes, and alternates with them. The anthers are erect, one longer than the other. Within the whorl of six stamens is a tri-car-pelled pistil, bearing a slender style and lobed stigma. The ovary is tricarpous (pl. I, fig. 7-7a), forming axillary placentae which bear numerous, irregularly arranged anatropous ovules. The ovules, which are suspended on long funiculi, are round to oblong, and possess superior micropyles at their maturity. The fruit is a membranous, loculicidally 3-valved capsule, possessing small, numerous, channeled and ridged seeds, which are grayish upon maturity.

The inflorescence starts as a rounded emergence within the sheath of the uppermost leaf and very early cuts off the bract (pl. I, fig. 1) at its basal portion. The bract which outgrows the inflorescence initial envelops it before the floral primordia are formed. After the bract has formed a complete envelope to the growing point of the inflorescence, this inflorescence initial cuts off simultaneously in regular succession lateral protuberances (pl. I, fig. 2-3), which later become the floral primordia. Each of these lateral floral primordia which are rounded outgrowths from the erect rachis of the nascent inflorescence,very soon cuts off on its periphery five mamellate humps of perianth segments (pl. I, fig. 4). Closely following the development of the perianth lobes, the stamens (pl. I, fig. 5) arise within the perianth segments as small papillae. After the perianth segments and the stamens have been fully differentiated, the carpels develop (pl. I, fig. 6–7). These elongate upward and fuse at their margins (pl. 1, fig. 7a–8). In other words the sequence of development of the floral organs in this weed is acropetal, and they arise as follows: perianth segments, stamens, and carpels. The same development of the floral organs was reported by Smith (1898) in *Pontederia cordata.*

MICROSPORANGE AND MICROSPORES

The stamens elongate upward, and very early differentiate the microsporanges and the filaments. The microsporange is four-lobed in transverse section with a central vascular strand becoming apparent as it matures. Three to four archesporial cells (pl. I, fig. 9) differentiate under each lobe, the development of which is that usually found in most of the Angiosperms. These archesporial cells form a single row equalling the whole length of the microsporange. The archesporial cells divide periclinally, and each gives rise to a primary parietal cell and a primary sporogenous cell (pl. 1, fig. 10). The primary parietal cells by successive divisions form from four to six layers of definite concentric parietal tissue (pl. 1, fig. 11–12), the outermost of which forms the endothecium. The innermost layer of the parietal tissue functions as the tapetum.

The primary sporogenous cells directly by division produce fifteen or more microspore mother-cells in transverse section. These microspore mother-cells enlarge (pl. I, fig. 12), and greatly differentiate from the rest of the surrounding cells. They are more or less polygonal in shape, and fit tightly together. Their cytoplasm is dense, and their nuclei are comparatively large, somewhat spherical with well defined nuclear membrane. Before cleavage the microspore mother-cells seem to separate *en masse* from the surrounding tissue with the tapetal cells closely adhering to them (pl. I, fig. 12). According to Smith (1898) the same behavior of the microspore mother-cells and the tapetum is also observable in *Eichornia crassipes*, where the tapetum of a distinct layer of small cells closely adheres to the microspore mother-cells and are often wedged among them. The tapetal cells, like those of *Eichornia*, Smith (1898), never become multinucleate. As the maximum enlargement of the microspore mother-cells is attained, they round up, break apart, and their walls become thicker (pl. I, fig. 13). The chromatin material becomes beaded in appearance, and the nucleus enters synapsis.

The subsequent division of the microspore mother-cells is successive as is true of most of the monocotyledones, each daughter cell forming a wall about itself before the second division takes place (pl. 1, fig. 14). The usual arrangement of the tetrads is shown in plate 1, figure 15, but an arrangement as in plate 1, figure 16 is also common. Similar tetrad formation is reported in *Eichornia crassipes* (Smith, 1898).

MEGASPORANGE AND MEGAGAMETOPHYTE

As the carpels develop and elongate, their margins fuse at the center and form three distinct loculi, each of which develops two longitudinal ridges running along the central axis (pl. I, fig. 8). These ridges are the placentae on which the very first sign of the development of the ovules as slight protuberances becomes apparent (pl. 2, fig. 18–19). These outgrowths, or ovules, which are arranged in irregular rows and more or less scattered on the placentae, soon become papillate as the carpels enlarge.

The young ovule (megasporange) consists of an epidermis and three rows of nucellar cells. At the time the microspore mother-cells are in synapsis, an archesporial cell becomes fully differentiated at the summit of the nucellus (pl. 2, fig. 20). As the megasporange elongates, the archesporial cell divides periclinally into an outer primary parietal cell and an inner sporogenous cell (pl. 2, fig. 21). At this time the inner integument which later consists of two layers of cells becomes differentiated. Further development of the primary sporogenous cell is normal. As the megasporange continues to grow, the primary sporogenous cell greatly enlarges and elongates, becoming densely filled with thick cytoplasm and much more enlarged towards its micropylar than at its chalazal end, and enters synapsis (pl. 2, fig. 22). By this time the two integuments are fully developed, both of which consist of two layers of cells. In *Eichornia crassipes* (1898) Smith, also finds two integuments, each possessing two layers of cells. The same is also true of *Heteranthera* (Coker, 1907). In *Pontederia*. however, the outer integument consists of three layers of cells (Coker, 1907), and the inner integument, of two layers.

By two successive divisions of the primary sporogenous cell, it gives rise to a linear tetrad of four megaspores (pl. 2, fig. 23-24), the chalazal megaspore of which becomes functional. The irregularities in the formation of the four megaspores found in *Heteranthera* (Coker, 1907) and *Pontederia* (Smith, 1898) were not observed in this species. At this time the nucellar cells show distinct signs of disintegration, so that the megagametophyte comes nearly to abut close to the epidermis of the megasporange.

The primary parietal cell remains undivided and never gives rise to an extensive parietal tissue.

The development of the functional chalazal megaspore is normal. The three micropylar megaspores degenerate, and by three successive divisions of the nucleus of the functional megaspore, a seven-celled megagametophyte is developed (pl. 2, fig. 25). This figure shows a megagametophyte ready to be fertilized. The cells are arranged in the usual fashion. The egg-apparatus consists of two synergids devoid of the distinct "filiform apparatus" found in *Eichornia crassipes* (Smith, 1898) and a megagamete which is relatively small. At the middle of the megagametophyte is the fusion nucleus. The antipodals are arranged in a row.

Fusion of the polar nuclei seems to take place long before fertilization, and this fusion nucleus usually stays for some time in the middle of the megagametophyte.

The antipodals are distinct, and they remain perfectly differentiated long after endosperm formation is well under way. They [are separated by definite yet faintly stainable walls, and may lie in a single row (pl. 2, fig. 25). The persistence of the antipodal cells has been also observed by Smith (1898, 1908) in *Pontederia* and *Eichornia*, and by Coker (1907) in *Heteranthera* and *Pontederia*. In *Heteranthera limosum* and *Pontederia cordata*, the lower end of the megagametophyte where the antipodals rest, develops scarcely at all in the subsequent development of the megasporange, and remains as a projecting pocket, from an apparent basal invagination.

THE ENDOSPERM

Soon after fertilization, the primary endosperm nucleus divides into two, one of which remains at the vicinity of the zygote, while the other migrates towards the chalazal end of the embryo-sac just above the antipodals (pl. 2, fig. 26), which remain distinct in an apparently small pocket similar to that found in the other genera of the Pontederiaceae. Some time after one of the endosperm nuclei has reached the distal end of the embryo-sac, there is a cytokenesis which cuts off a small cell at the lower end (pl. 2, fig. 27), and the primary endosperm cell becomes virtually two-celled, a basal (basal apparatus) and an upper endosperm cell. The subsequent development of the upper endosperm cell is that usually found in the primary endosperm cell. There then follows repeated divisions of the nuclei in the upper endosperm derivative (pl. 2, fig. 28). As free nuclear divisions proceed, there occurs a disintegration of the nucellar tissue towards the chalazal region of the megasporange, and the basal apparatus together with the three degenerating antipodal cells come to lie first on one side of the embryo-sac (pl. 2, fig. 30), and later at the middle where they finally disappear. Following this multinucleate condition of the upper endosperm cell is a free cell formation, and the embryo-sac finally becomes entirely filled with endosperm tissue as the seed matures.

Simultaneous with the free mitotic divisions of the nuclei in the upper endosperm cell, the nucleus of the basal apparatus divides too. Instead of undergoing a series of divisions, the nucleus divides only twice (pl. 2, fig. 30) giving rise to only four nuclei. In plate 2, figure 29 only three of the four nuclei could be located, one is apparently missing. The writer has never observed any case where more than four nuclei are present in this basal apparatus. No free cell formation follows this nucleate stage, and in this respect *Monochoria* differs from either *Heteranthera* or *Pontederia* (Coker, 1907) where the basal endosperm becomes cellular.

In *Pontederia cordata*, Coker (1907) finds that the primary endosperm nucleus lies first above the antipodal pocket where it finally divides. From this first division of the primary endosperm nucleus, a cross wall is formed cutting the embryo-sac into two chambers. Smith (1908) confirms this finding, too. The endosperm nucleus in each chamber divides repeatedly, and the protoplasm increases in amount. The lower tip of the embryo-sac does not increase in size, and as the part above it grows outward and develops downward at the edges, the antipodal pocket comes finally to hang from the center of the considerable depression. The antipodals remain differentiated even after the walls have appeared in the endosperm. The development of the endosperm in the upper chamber is normal and follows that of the primary endosperm cell. After repeated mitotic divisions in the lower chamber, multinucleate cells are formed, their walls becoming thickened, and their nuclei seem to show a tendency to fuse. As the seed reaches maturity the upper endosperm cells come to be filled with starch, while the cell contents of the lower endosperm show signs of degeneration.

In *Heteranthera*, Coker (1907) observes identical endosperm formation, and that the cells formed in the lower chamber are much larger than those in the upper, but unlike *Pontederia*, they are not multinucleate.

THE SEED

The structure of a nearly mature seed of this plant presents some similarities to that of *Heteranthera* (Coker, 1907). Its axial embryo extends nearly the whole length of the seed, and is surrounded by a large-celled endosperm, which, except in the immediate neighborhood of the embryo, is densely packed with starch grains. The nucellar tissue is entirely wanting except a perceptible portion at the nucellar part of the seed. The aleurone layer of the endosperm (pl. 1, fig. 17) lies immediately beneath the heavy cellulose membrane secreted by the inner integument. The inner integument (blackened) is entirely crushed, and its cells stain deeply, losing their outlines. Outside the inner integument lies another cellulose membrane represented by the white layer in the figure. This membrane seems to be secreted by the outer integumentary cells during the development of the seed. The outer layer of the outer integument remains small, rectangular, with the long axis running perpendicular to the longitudinal axis of the seed. The cells of the inner layer, on the contrary, undergo enlargement perpendicular to the long axis of the seed. Like *Heteranthera* (Coker, 1907), the outer walls dip inward in a regular curve, thus giving the seed a channeled and ridged surface. In *Heteranthera* and *Eichornia*, Coker (1907) also observes that the cells of the inner layer become much elongated, perpendicular to the long axis of the seed, and flattened in that direction. The partition parallel to the long axis of the seed is much higher at the ends than in the center, and the outer edges dip inward in a regular curve, which is followed by the outer layer of cells, resulting in the channeled and ridged surface of the seed also in a longitudinal direction. Another thing of interest in *Heteranthera* is that these enlarged cells are multinucleate, a case not true of *Monochoria*.

In *Pontederia*, (Coker, 1907) the outer integument consists of three layers of cells, the two outer layers of which remain small, thin, and rectangular, and those of the inner layer are of the same height throughout, enlarged, thus giving a smooth, instead of a ridged, surface to the seed.

SUMMARY

The racemose inflorescence arises as a rounded emergence within the sheath of the uppermost leaf, and very early cuts off the bract at its basal portion. After this bract has entirely enveloped the inflorescence, initial lateral protuberances (floral primordia) are cut off simultaneously in regular succession on the rachis of the inflorescence initial.

The development of the floral organs is acropetal, and they arise as follows: perianth, stamens and carpels.

The stamen early differentiates the microsporange and the filament. A plate of three to four archesporial cells is formed and these divide periclinally forming the primary parietal layer and the primary sporogenous cells. The primary parietal layer gives rise to a parietal tissue of four to six layers of cells, the outer layer of which becomes the endothecium, while the innermost layer functions as the tapetum. No multinucleate tapetal cells have been observed in *Monochoria.* The intermediate layers may remain differentiated even in the mature microsporange.

By subsequent divisions of the primary sporogenous cells, fifteen or more microspore mother-cells are formed, and these divide successively in forming the tetrads.

Numerous, irregularly arranged megasporanges arise from the axillary placentae. At the time the microspore mother-cells are in synapsis, a single archesporial cell very early differentiates at the summit of the megasporange, and before the integuments are formed, this divides periclinally into a primary parietal cell and a primary sporogenous cell. The primary parietal cell remains undivided and never gives rise to an extensive parietal tissue. The primary sporogenous cell on the other hand, by two successive divisions, gives rise to a linear tetrad of four megaspores, the chalazal megaspore of which becomes functional.

A normal seven-celled megagametophyte is formed.

The integuments are fully differentiated at the synapsis of the megaspore mother-cell, and each consists of two layers of cells.

The development of the endosperm proceeds soon after fertilization. The primary endosperm nucleus divides into two, one of which migrates to the chalaza, while the other remains at the vicinity of the zygote. By cytokenesis, the primary endosperm cell becomes divided into two cells, upper and lower (basal apparatus) cells. The development of the endosperm in the upper cell is that usually found in the primary endosperm cell. The endosperm nucleus in the basal apparatus only divides twice, and remains multinucleate until it disintegrates with the antipodal cells during the development of the endosperm of the upper derivative of the primary endosperm cell.

The structure of the nearly mature seed presents nothing novel. It consists of an axial embryo surrounded by a large-celled endosperm which is starchy. The seed coat consists of the crushed inner integument with its secreted heavy cellulose membrane and the two layers of cells of the outer integument. The outer layer of the outer integument consists of small rectangular cells, while the inner layer is composed of enlarged cells, both of which have their long axis perpendicular to the long axis of the seed. The inner layer of cells of the outer integument are not multinucleate.

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EXPLANATION OF THE PLATES

Parts of the inflorescence, flower and the seed have been designated as follows: aleurone (*a*), antipodals (*an*), basal apparatus (*ap*), bract (*br*), carpels (*c*), endosperm (*en*), fusion nucleus (*fn*), inner integument (*ii*), locule (*le*), leaf (*l*), megagamete (*mge*), microspore mother-cell (*mmc*), outer integument (*oi*), ovule (*ov*), perianth (*pe*), placenta (*pl*), parietal tissue (*pt*), stamens (*st*), tapetum (*t*), and zygote (*ze*).

PLATE 1. *Monochoria vaginalis* (BURM. F.) PRESL

Fig. 1. Longitudinal section of a young inflorescence showing the beginnings of the bract. × 156.

Fig. 2. Longitudinal section of the whole inflorescence showing the origin of the floral primordium. × 417.

Fig. 3. Longitudinal section of the floral primordia. × 417.

Fig. 4. Longitudinal section of a single floral primordium showing the beginnings of the perianth and the stamens. × 417.

Fig. 5. Longitudinal section of an older flower showing the origin of the carpels. × 417.

Fig. 6. Longitudinal section of a much older flower showing perianth segments, stamens, and carpels. × 417.

Fig. 7. Longitudinal section of a young flower with all its parts. × 417.

Fig. 8. Transverse section of same flower to show the relative positions of all its parts. × 417.

Fig. 9. Portion of a transverse section of a young microsporange showing archesporial cells well differentiated. × 706.

Fig. 10. Division of one of the archesporial cells into primary parietal cell and primary sporogenous cell. × 706.

Fig. 11. Portion of a transverse section of an older microsporange showing a mass of sporogenous cells, and two layers of cells of the parietal tissue. × 706.

Fig. 12. Portion of a transverse section of an older microsporange to show tapetal cells adhering to the microspore mother-cells. × 706.

Fig. 13. Section of an older microspore mother-cell after rounding up. × 706.

Fig. 14. A dyad. × 706.

Fig. 15–16. Tetrads. × 706.

Fig. 17. Portion of a longitudinal section of a nearly mature seed showing the coats and portion of the endosperm. × 447.

PLATE 2. *Monochoria vaginalis* (BURM. F.) PRESL

Fig. 18. Longitudinal section of the carpel showing the placenta and beginnings of the ovules (megasporanges). × 417.

Fig. 19. Longitudinal section of a much older carpel to show papillate beginnings of the megasporanges. × 417.

Fig. 20. Nucellus of a young megasporange with an archesporial cell. × 706.

Fig. 21. An older megasporange showing the primary parietal cell and primary sporogenous cell. Note the beginnings of the inner integument. × 706.

Fig. 22. A much older megasporange showing the primary sporogenous cell in synapsis. × 706.

Fig. 23. Apex of the nucellus showing two megaspores. × 706.

Fig. 24. Apex of the nucellus of an older megasporange showing four megaspores. × 706.

Fig. 25. A megagametophyte ready to be fertilized. × 593.

Fig. 26. Chalazal portion of the embryo-sac showing the migration of one of the derivatives of the primary endosperm nucleus. × 706.

Fig. 27. After cutting off a small basal cell (basal apparatus) from the primary endosperm cell. × 706.

Fig. 28. Showing free nuclear divisions in both derivatives of the primary endosperm cell. × 706.

Fig. 29. Chalazal portion of the endosperm showing the basal apparatus. × 706.

Fig. 30. Showing growth of the upper endosperm and the degeneration of the basal apparatus and the antipodal cells. × 326.

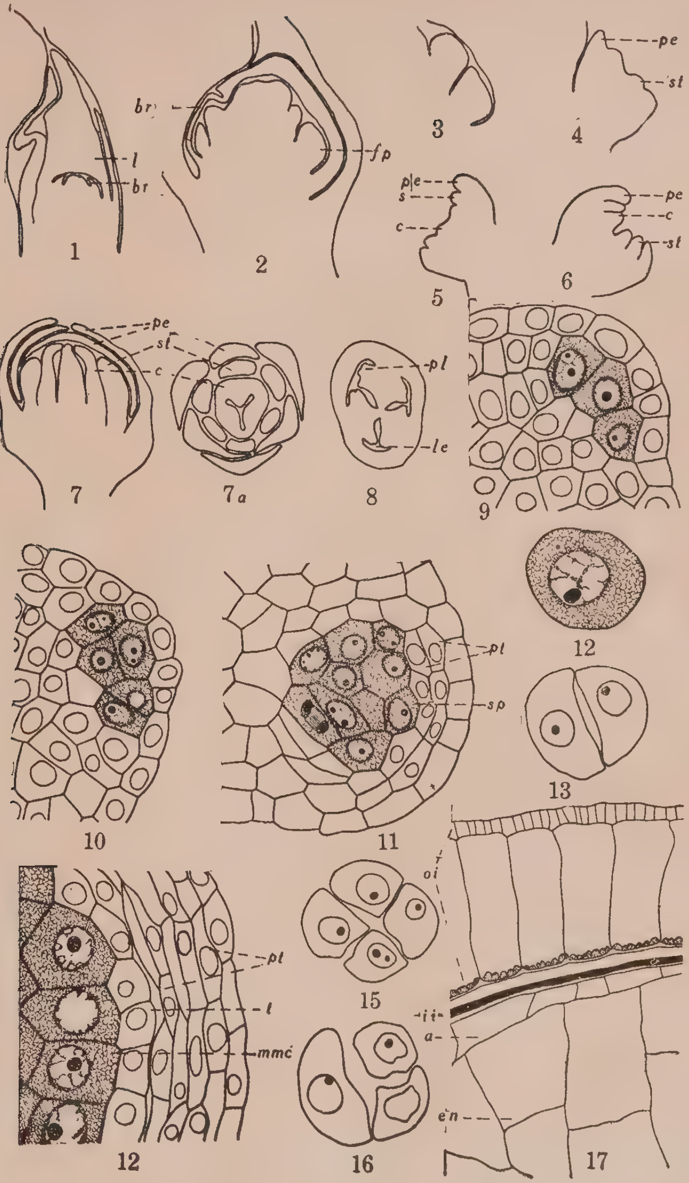
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Plate I

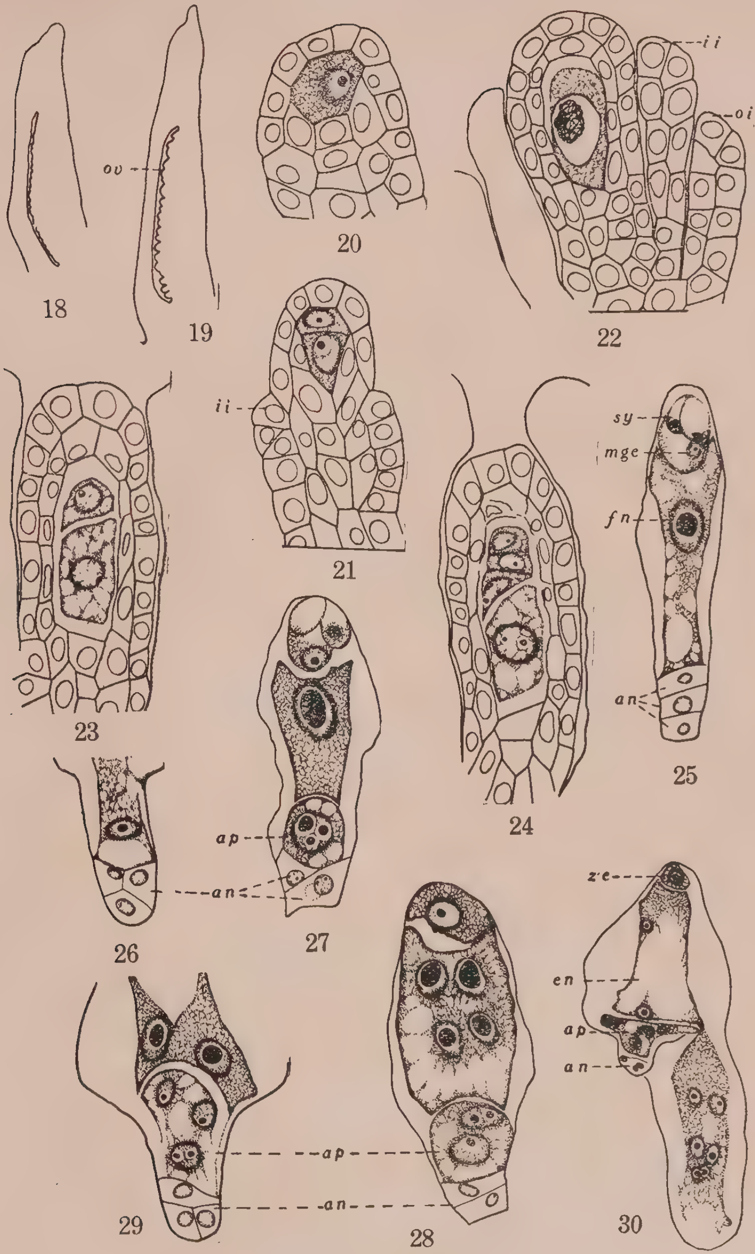
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Plate II

A NON-SYMBIOTIC NITROGEN-FIXING ORGANISM OF THE GENUS AZOTOBACTER IN SOME PHILIPPINE SOILS[1]

DIONISIO I. AQUINO[2]

WITH THREE TEXT FIGURES

The presence, number and activities of the microörganic populations of the soil as influenced by various factors and their relation to the soil fertility have, in recent years, been the subject of numerous investigations. The idea that nitrogen may be incorporated in the soil through the agency of microbial activities has been definitely established as a fact. Considerable attention has been directed to the problem of nitrogen fixation in the soil and several workers have succeeded in their attempts to isolate from the soil some of the native (*autochtonous*) microflora concerned in the process of the fixation of atmospheric nitrogen in agricultural soils.

REVIEW OF THE LITERATURE

Studies on the nitrogen-fixing organisms in soil

Some of the most outstanding contributions dealing with the isolation and study of nitrogen fixers from the soil are the pioneer work of Winogradsky and Beijerinck. Winogradsky (1893) was the first to isolate the anaerobic and non-symbiotic nitrogen-fixing organism; this he named *Clostridium pasteurianum*. In 1901, Beijerinck (1901) was able to isolate two aerobic organisms, *Azotobacter chroococcum* and *Azotobacter agile*. Beijerinck and Van Delden (1902) reported that various forms of organisms of the genus *Glanulobacter* (varieties of *Bac. asterosporus*) were capable of fixing small quantities of nitrogen. Lipman (1903) reported the isolation of *Azotobacter vinelandii* and *Azotobacter beijerinckii* both of which are aerobic forms. Löhnis and Westermann (1908) isolated the so-called *Azotobacter vitreum*. Some of the factors that tend to stimulate or retard the physiological activities of these nitrogen-fixing organisms both in soil and in artificial media have been studied by various investigators.

Occurrence of nitrogen-fixers in soil

The organisms of the genus *Clostridium* are known to be of universal occurrence and more generally distributed in soils than those of the *Azotobacter* group. This has been attributed primarily to the fact that the *Clos-*

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[2] The author wishes to express his indebtedness to Miss Mamerta Manahan, assistant in chemistry, for her valuable help in the nitrogen determination and to Dr. R. L. Pendleton for his suggestions regarding the manuscript.

tridium flora are not as easily influenced by soil reactions as those of the *Azotobacter* organisms. Waksman (1918) claimed that *Azotobacter* cannot develop in a soil having an acidity of greater than pH 6.0. If, however, the soil reaction is adjusted by means of lime in order that the pH value becomes greater than 6.0 the development of an *Azotobacter* flora may be expected. In a few soils, however, which were known to be more acid than pH 6.0 the occurrence of some *Azotobacter* organisms was noted although they showed a rather poor growth and were claimed to be low in their nitrogen-fixing ability (1930). These groups of nitrogen gatherers were claimed to be of great significance in the maintenance of the nitrogen supply of the soil and their growth and activities are greatly influenced by soil deficiencies for lime and phosphorus.

Results of the investigations made by various workers, as revealed by Waksman (1927), showed that *Azotobacter* organisms occurred in most soils in Java, India, in some soils in Denmark, Russia, and in a half of Polish soils examined. In the United States, especially in Utah soils, according to Greaves (1918), and in one-third of all the cultivated soils in Japan, Yamagata and Itano (1923), the distribution of *Azotobacter* has also been demonstrated. *Azotobacter* organisms according to Walker and Brown (1930) are found in some Iowa soils. But in Finnish soils (1927) such organisms have been reported to be absent, even in those soils which were well buffered and well supplied with lime. The occurrence of *Azotobacter* flora or any other forms of nitrogen fixers in Philippine soils, so far as the writer knows, has not been reported. The work reported in this paper was planned to isolate from the soil some of the organisms involved in the process of nitrogen fixation and to study their morphological and cultural characteristics. It is hoped that this study may contribute something to our knowledge along this line and supplement the results already obtained by various investigators in other countries.

MATERIALS AND METHOD

In this study soils collected from the College of Agriculture Experiment Station fields were used.

Methods of isolation

In an attempt to isolate in pure culture some of the nitrogen-fixing organisms, methods suggested by Winogradsky and other investigators as outlined in the *Laboratory Manual of General Microbiology* by Fred and Waksman (1928) were followed.

Direct microscopic method (*Winogradsky*)

To 100 grams of air-dried, freshly sieved soil placed in a 250 cc. casserole, 5 grams of pulverized soluble starch were added and thoroughly mixed. The starch furnishes the necessary energy for the *Azotobacter* organisms. Distilled water was added to the mixture in a sufficient amount to make a thick paste of soil. By means of a spatula the soil paste was transferred and well pressed into small Petri dishes. A wet glass slide was employed in making the surface as smooth and even as possible. The plates or "mud pies" were placed in a pan on a piece of moist blotting paper, covered and incubated at room temperature for a period of 48 to 72 hours after which time the plates were examined for the presence of *Azotobacter* colonies. The bacterial colonies appeared as limpid, raised, convex and semi-opaque dots and varied in diameter from .4 to 1.8 mm.

An examination of the bacterial suspensions under the microscope showed that only very few individuals possess the power of motility. There was no attempt, however, to stain the organisms for fear that they were still in mixed cultures.

Transfers by means of a sterile platinum loop were made directly into agar slants prepared by adding 2 per cent of washed agar to the nitrogen-free mannitol solution the composition of which is as follows:

Nitrogen-free mannitol solution

Mannitol	10.0 grams
Dipotassium phosphate (K_2HPO_4)	0.5 gram
Magnesium sulfate ($MgSO_4 . 7H_2O$)	0.2 gram
Sodium chloride (NaCl)	0.2 gram
Manganese sulfate ($MnSO_4 . 2H_2O$)	Trace
Ferric chloride ($FeCl_3 . 6H_2O$)	Trace
Distilled water	1,000.0 cc.

Repeated transfers were made in order to insure that the organisms were in pure culture.

Isolation of the organism in solution medium

The isolation of the organism in this study was by the use of the mannitol solution given above. After the medium was prepared, the reaction was adjusted to pH 7.0

Fifty cc. portions of the medium were placed in 150 cc. Erlenmeyer flasks and sterilized in the autoclave at 15 pounds pressure for about 20 minutes. Each flask was inoculated with one gram of the freshly sieved soil and the cultures were incubated at room temperature. After 7 to 8 days all the inoculated cultures showed signs of growth. The cultures were observed to have a more or less crude floating membrane on top of the liquid. The color of the solution appeared to be pale yellow to brownish.

Microscopic examinations of the organisms in hanging drops indicated that only a very few cells seemed motile.

By means of a platinum loop, transfers from the inoculated flasks were made into 10 cc. of a physiological salt solution. This was shaken and fresh flasks containing the nitrogen-free medium were again inoculated with bacterial suspension. After 6 to 7 days an indication of growth became apparent, (fig. 1). The solution at this time appeared to be cloudy, with the formation of a pellicle-like structure on the surface of the liquid. The incubation period was prolonged and after 3 days more the solution became gray in color. One of the inoculated flasks showed signs of contamination. The several subcultures made with the use of a fresh lot of sterile medium resulted in a gradual purification of the culture from contaminating organisms.

By the usual dilution method several plates were poured and the cultures were incubated in an inverted position at room temperature for a period of 7 days, (fig. 2). No attempt was made to count the bacterial colonies. The characteristics of the colonies were as follows: Colonies appeared to be raised, white, viscid and semi-opaque. The size ranged from .3 to 1 mm. in diameter. Under the microscope the bacterial cells varied in shape from cocci to rods.

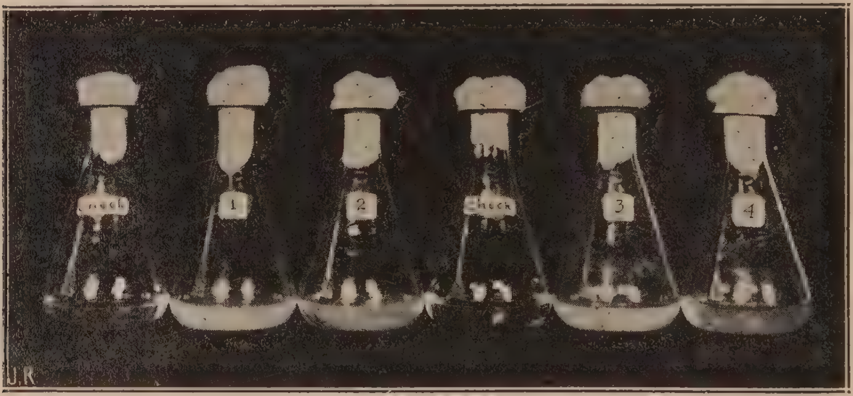

Fig. 1.—Cultures (7 days old) showing an indication of a vigorous growth in the nitrogen-free solution.

Transfers to the mannitol agar slants were made and incubated in the usual way, and after 4 to 5 days an indication of a vigorous growth was noted. By repeated transfers to fresh slants, a non-pigmented species of *Azotobacter* was finally isolated in pure culture, (fig. 3).

An examination of the organisms in hanging drops indicated that only a few cells in young cultures appeared to be capable of motility. Repeated attempts to stain the organisms for the detection of the presence of a flagellum or flagella were unsuccessful.

The organisms isolated by the two methods, both directly from the soil and through the liquid medium, when examined under the microscope were found to be identical, hence they were believed to be of the same species.

MORPHOLOGICAL AND CULTURAL CHARACTERISTICS OF THE ORGANISMS

Smears secured from young cultures on mannitol slants were stained with the ordinary stains, gentian violet and carbol fuchsin. The organisms appeared to vary from coccus to rod-shaped forms. The sizes ranged from .5 to .8×1.2 to 1.6 μ for the cocci and from .5 to .9×1.8 to 2.0 μ for the rods. The cells were in most cases transparent.

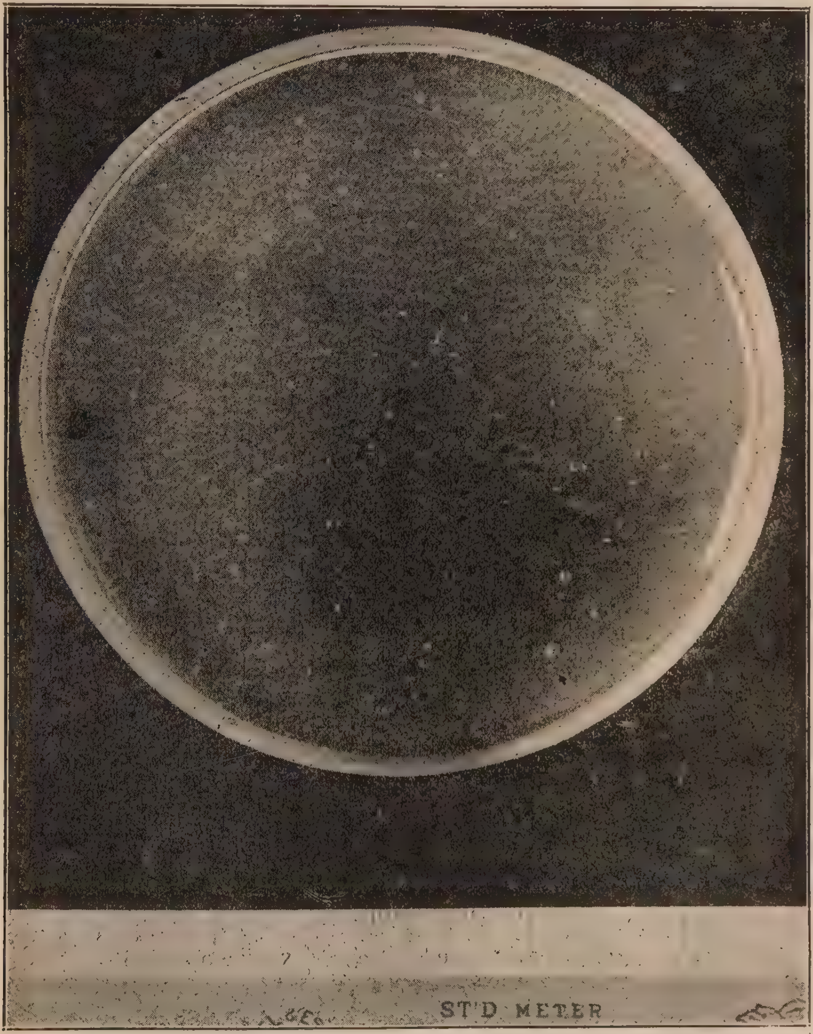

Fig. 2.—A mannitol agar plate (7 days old) showing the characteristic growth of *Azotobacter* colonies.

NITROGEN FIXATION STUDIES

The following experiment was planned to determine whether or not the organism isolated in pure culture is a true nitrogen fixer.

Fifty cc. portions of nitrogen-free mannitol solution having a pH of 7.0 were placed in 150 cc. Erlenmeyer flasks, sterilized and inoculated with

5 cc. of the bacterial suspension. Duplicate cultures were prepared and incubated at room temperature for a period of 2 and 4 weeks, respectively. Checks were included in the tests. As indicated in the table below, after the incubation period, one cc. of chloroform was added to each one of the flasks in order to stop any further activities of the organisms. The determination of nitrogen in the cultures was conducted in the Department of Agricultural Chemistry laboratory under the close supervision of Miss Mamerta Manahan, assistant in chemistry.

The results of this study are shown in the following table:

Showing the amount of nitrogen in milligrams fixed by the organisms in solution cultures

No. of flask	Period of incubation	Milligrams nitrogen fixed by organisms
1.........	2 weeks	1.6
2.........	2 weeks	0.3[a]
3.........	4 weeks	3.1
4.........	4 weeks	2.9

[a] This culture showed indications of contamination.

The results given in the table show conclusively that the organism isolated in pure culture is a non-symbiotic nitrogen fixer. The checks which were included in the tests showed only traces of nitrogen. The efficiency of the organism to fix atmospheric nitrogen became more apparent when the incubation period was prolonged to 4 weeks.

CULTURAL CHARACTERISTICS

To determine the ability of the *Azotobacter* organism to liquefy gelatin the following experiment was undertaken.

A solution the composition of which appears below was prepared. The reaction was adjusted to pH 7.0:

Mannitol-phosphate solution

Mannitol [$C_6H_8(OH)_6$]........................	10.0 grams
Magnesium sulfate ($MgSO_4.7H_2O$)....................	0.2 gram
Monopotassium phosphate (KH_2PO_4)................	0.2 gram
Sodium chloride (NaCl)...........................	0.2 gram
Clacium sulfate ($CaSO_4.2H_2O$)......................	0.1 gram
Calcium carbonate ($CaCO_3$)........................	5.0 grams
Distilled water..................................	1,000.0 cc.

In the preparation of a solid medium 150 grams of gelatin were added to a liter of the mannitol-phosphate solution. The medium was then tubed, sterilized and inoculated with the pure culture. The tubes were incubated at a temperature of from 22 to 23°C. for a period of 14 days. The desired temperature was made possible by keeping the culture tubes in basins of water in a cupboard. The water was changed at least two or three times a day. The daily observations made during the course of the experiment showed that there was a vigorous growth of the organisms but no indication of a gelatin liquefaction was noted. The results seemed to indicate that the organism in question is not proteolytic.

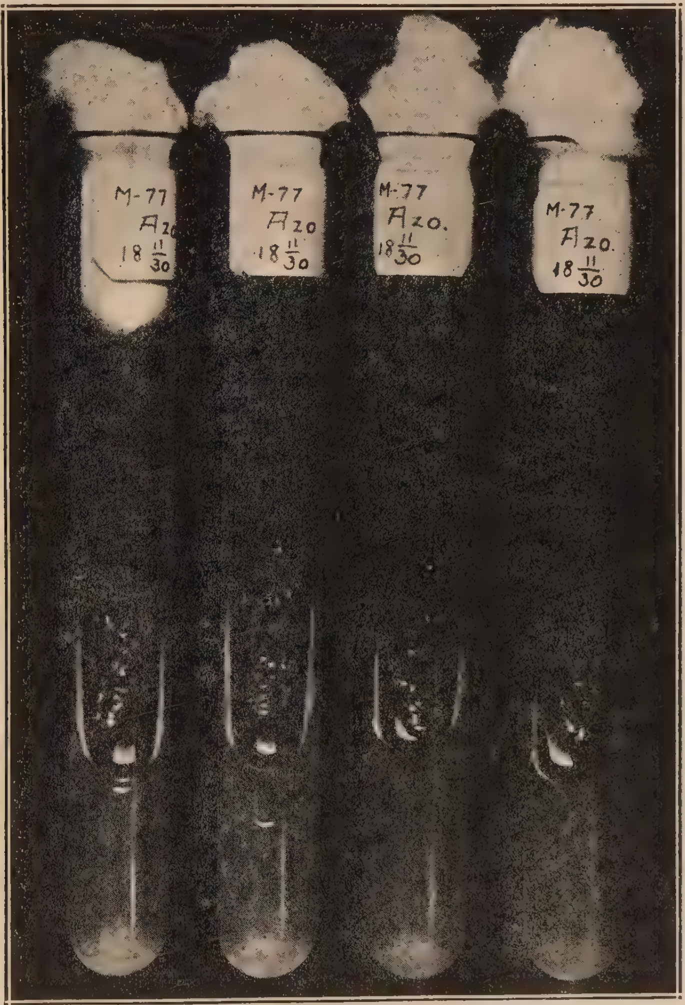

Fig. 3.—Organisms (6 days old) growing in pure culture on a mannitol agar slants.

SUMMARY AND CONCLUSIONS

A review is presented of the occurrence and activities of several microörganisms involved in the nitrogen fixation process.

Following the methods suggested by Winogradsky and other investigators an aerobic and non-pigmented organism of the genus *Azotobacter* capable of fixing an atmospheric nitrogen has been isolated from some Philippine soils.

The organism isolated in pure culture when stained with ordinary stains appeared to be transparent, and the sizes ranged from .5 to .8×1.2 to 1.6 μ for the cocci and from .5 to .9×1.8 to 2.0 μ for the rods.

From the results obtained the amount of atmospheric nitrogen fixed by the organism and the period of incubation seem to run parallel, that is, a greater quantity of nitrogen fixed was obtained when the incubation period was made longer (4 weeks).

The organism studied is not proteolytic as evidenced by the fact that it did not liquefy the gelatin.

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THE NUTRITIVE VALUE OF GREEN, RIPE AND SPORT COCONUTS (BUKO, NIYOG AND MAKAPUNO)[1]

F. T. ADRIANO AND MAMERTA MANAHAN
Department of Agricultural Chemistry

The coconut, *Cocos nucifera* L., is one of the important export crops of the Philippines. According to the latest report of the Bureau of Commerce and Industry (1928) the total coconut exports comprising oil, copra (the dried meat of the coconuts), dessicated and shredded coconut and copra meal, amounted to ₱105,282,472.00 or 34 per cent of the total exports for that year. Table 1 shows the value of the coconut products exported from the Philippines in 1928 compared with value of three other leading export products.

TABLE 1

Value of coconut products exported from the Philippines in 1928 compared with that of three other leading export products

PRODUCTS	VALUE OF EXPORTS	PERCENTAGE OF TOTAL EXPORTS ₱310,109,092[a]
Coconut:		
Oil	₱46,978.345	15.15
Copra	45,084,682	14.54
Dessicated and shredded	7,447,171	2.40
Copra meal	5,772,274	1.86
Total	₱105,282,472	33.95
Sugar	95,085,879	30.66
Abaca	53,187,212	17.15
Tobacco	17,142,873	5.53

[a] Philippine peso equals 50 cents United States currency.

Besides its importance as an export, coconut is used extensively in the Islands for food and drink. The nuts can be used as food at different stages of development from the immature to the mature stage.

In the provinces surrounding Manila, the green coconut is called *buko*. There are three different kinds of *buko* sold in the market; (*a*) *mala-uhog*, a term, (Tagalog) meaning similar to mucus. In this kind the coconut is at a stage of development when the meat is very soft and jelly-like and can be removed from the shell with a spoon. It is consumed in relatively large quantities as it is easily procured and is ready for eating and is very palatable and the water obtained from the nut is a very refreshing drink.

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[1] Experiment Station contribution No. 735. Received for publication May 28, 1931.

The coconut is sold also at a more mature stage when the meat is of the consistency of hard boiled rice. This stage is considered by many as the best; it is eaten raw also. In railroad stations in coconut regions large numbers of coconuts in this stage are sold. In the provinces surrounding Manila this product is called (*b*) *mala-kanin* meaning like boiled rice.

A third stage of development of the coconut is when the meat is rather hard but not so hard as that of the mature nut. This coconut meat is usually used for making sweets, although some people prefer it to the *mala-kanin* for eating raw. This stage is called (*c*) *mala-katad,* meaning like leather.

In the Tagalog dialect the mature coconut is called *niyog*. These nuts are used in making copra, and sweets and in special Filipino dishes. When used in home cooking the meat is grated and the milk is extracted therefrom by using a small amount of maceration water and expressing the milk through cheesecloth.

Makapuno is a Tagalog term for the sport fruit of the coconut. It contains a meat which is white, viscous, translucent and jelly-like, approaching the consistency of hard boiled rice. In some cases an oily-like liquid is present. *Makapuno* is considered a delicacy and is used largely for making preserves and the expensive and highly popular makapuno ice cream. It cannot be kept in storage. It will not germinate.

The prices in the Los Baños and San Pablo markets in 1931 of the different kinds of nuts described above were as follows:

1. *Buko* from ₱0.04 to ₱0.05 each.
2. *Niyog* from ₱0.05 to ₱0.06 each.
3. *Makapuno* from ₱0.25 to ₱0.50 each.

Although the coconut is used so extensively as an article of food and drink, strange as it may seem, little has been done on its chemical analysis. Gonzalez (1914) made a preliminary study on the changes occurring in the ripening of coconuts. He also described the *makapuno* and its formation. Vista (1915) reported a more extensive although incomplete study on the chemical changes in the ripening coconuts.

From the standpoint of nutrition, a study which is at present receiving much attention in the Philippines, it is important to know the chemical composition of the coconut in the various stages of development in which it is used as food or drink.

MATERIALS AND METHODS

The different kinds of *buko* were bought from vendors at College Station, Laguna and from vendors along the Laguna-Manila road near the College of Agriculture, Los Baños, Laguna. The *niyog* were bought from the vendors in the Coconut Grove, a barrio adjacent to the College Campus. Some ripe nuts from the plantation of the College of Agriculture were also used. In the case of *niyog*, two kinds were analyzed, the ordinary mature nuts and those with embryo. The *makapuno* nuts were obtained in Los Baños and San Pablo, Laguna. Three kinds were analyzed. In so far as the writers are aware, the age of the *makapuno* cannot be ascertained from the texture of the meat as can be done in the case of the *buko*. In one kind, the meat which is of a consistency similar to hard boiled rice, is found to fill the whole shell. In a second kind, the meat next to the shell is like hard boiled rice but the rest (30-40 per cent) is soft and viscous. A third kind is where the contents consist of three layers, the first layer which is next to the shell is like hard boiled rice, the next layer is soft and viscous and the innermost (third layer) is semi-liquid and oily in nature.

All the nuts used in this study were carefully selected and those without husks were discarded.

The nusts were weighed separately in a Cenco balance. The weights of the husk, milk (water), shell and meat were determined. The analyses reported in this paper were performed on the meat.

The meat was carefully and rapidly sampled and analyzed for the proximate constituents.

The methods of analysis employed were those adopted by the Association of Official Agricultural Chemists (1925). In some cases modified methods were used. These modified methods were described by the senior author in a paper published in this journal in 1929.

RESULTS

Table 2 gives the results of analyses of three kinds of *buko*, the *mala-uhog*, *mala-kanin* and *mala-katad;* two kinds of *niyog*, one without and one with embryo; and three kinds of *makapuno*.

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TABLE 2

The chemical composition of green, ripe and sport coconuts (buko, niyog and makapuno)

SAMPLE	WEIGHT OF NUTS	MILK	HUSK	SHELL	MEAT	MOISTURE	ASH		CRUDE FATS (ETHER EXTRACT)		PROTEINS N × 6.25		CRUDE FIBER		TOTAL CARBOHYDRATES		FUEL VALUE PER 100 GRAMS	
							Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis	Wet basis	Dry basis
	grams	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*	*calories*
I. (*a*) Buko—(Mala-uhog)	3575	14.17	74.65	6.48	4.80	91.81	0.77	9.40	2.20	26.86	0.91	11.11	0.68	8.30	3.63	44.32	39	476
	3507	15.17	74.13	6.79	3.91	92.12	0.86	10.91	1.48	18.78	0.94	11 93	0.42	5.33	4.18	53.72	35	444
	3731	20.76	66.76	8.54	3.94	92.09	0.71	8.98	1.64	20.73	0.85	10.75	0.40	5.06	4.31	54.48	36	455
Average	3604	16.70	71.85	7.27	4.22	92.01	0.78	9.76	1.77	22.12	0.90	11.26	0.50	6.23	4.04	50.84	37	458
I. (*b*) Buko—(Mala-kanin)	2802	13.84	61.71	6.51	18.07	81.69	1.05	5.73	7.49	40.91	1.29	7.05	3.84	20.97	4.64	25.34	94	513
	2390	18.85	66.74	7.44	6.97	88.46	0.99	8.58	2 59	22.44	0.88	7.63	1.59	13.78	5.49	47.57	50	433
	2310	19.62	67.44	6.49	6.45	86.87	0.99	7.54	4.87	37.09	1.00	7.62	1.76	13.40	4.51	34.35	68	517
	2500	24.60	58.60	8.96	7.48	87.24	1.01	7.92	4.37	34.25	1.19	9.33	1.15	9.01	5.04	39.50	67	525
	2747	18.91	67.78	6.35	6.95	86.76	0.89	6.72	5.79	43.73	1.74	13.14	2.92	22.05	1.90	14.35	69	551
	3424	19.66	69.39	7.71	6.34	84.42	1.04	6.68	7.27	46.66	1.84	11.81	3.19	20.47	2.24	14.38	84	539
Average	2696	19.25	65.28	7.24	8.71	85.91	1.00	7.20	5.40	37.51	1.32	9.43	2.41	16.61	3.97	29.25	72	508
I. (*c*) Buko—(Mala-katad)	2160	20.91	68.70	10.83	9.56	76.05	1.16	4.84	13.14	54.86	1.19	4.97	2.48	10.35	5.98	24.97	152	635
	2137	15.91	67.84	6.90	9.35	77.85	1.00	4.51	9.15	41.31	2.66	12.01	2.80	12.64	6.54	29.53	123	555
	2245	14.52	75.68	5.75	4.05	77.86	1.45	6.55	11.46	51.76	3.60	16.26	0.93	4.20	4.70	21.23	141	637
	2578	20.56	62.52	6.82	10.08	73.08	0.78	2.90	8.48	31.50	1.77	6.58	6.64	24.67	9.25	34.36	124	461
	2333	17.21	68.35	5.26	9.19	78.28	1.03	4.74	10.05	46.27	0.35	1.61	6.25	28.77	4.04	18.60	112	516
Average	2291	17.93	68.62	7.11	8.45	76.62	1.08	4.71	10.46	45.14	1.91	8.29	3.82	16.13	6.10	25.74	130	561
General Average	2746	18.19	67.88	7.20	7.65	83.90	0.98	6.86	6.43	36.94	1.44	9.41	2.50	14.21	4.75	32.62	85	518
II. (*a*) Niyog	1092	36.17	3.11	18.25	42.46	50.31	1.16	2.33	30.05	60.47	3.32	6.68	2.26	4.55	12.90	25.96	346	696
	1360	27.06	28.16	13.83	30.95	51.63	1.23	2.54	30.90	63.88	2.41	4.98	4.92	10.17	8.91	18.42	334	691
	1070	30.19	1.34	23 36	44.11	52.39	1.23	2.58	34.15	71.73	3.00	6.30	1.95	4.10	7.28	15.29	360	756
	1207	29.05	4.30	20.25	46.40	47.78	1.20	2.30	33.15	63.48	2.69	5.15	4.55	8.71	10.63	20.36	363	695
	1136	36.69	3.75	19.80	39.76	49.22	1.08	2.13	25.79	50.79	4.57	9.00	3.57	7.03	15.77	31.06	323	636
	——	——	——	——	34.61	48.85	1.19	2.33	30.78	60.18	3.69	7.21	2.59	5.06	12.90	25.22	354	692
	1475	26.01	34.10	13.55	26.34	52.34	1.27	2.67	33.05	70.22	2.79	5.85	2.20	4.62	8.35	17.52	353	741
Average	1223	30.86	12.46	18.17	35.38	50.36	1.19	2.41	31.12	62.96	3.21	6.45	3.15	6.32	10.85	21.98	347	701
II. (*b*) Niyog with embryo	636	6.68	42.53	19.87	30.92	36.46	1.18	1.86	45.35	71.37	5.44	8.56	2.41	3.79	9.16	14.42	482	759
	654	9.72	38.85	19.57	31.88	46.35	1.14	2.13	36.43	67.90	4.69	8.74	2.16	4.03	9.23	17.20	396	738
Average	645	8.20	40.69	19.72	31.40	41.41	1.16	2.00	40.89	69.64	5.07	8.65	2.29	3.91	9.20	15.81	439	749
General Average	1079	25.20	19.52	18.56	36.38	48.37	1.19	2.32	33.29	64.45	3.62	6.94	2.96	5.78	10.57	20.61	368	723
III. (*a*) Makapuno—Three layers, (Semi-liquid, soft and hard meat)	1291	——	37.20	15.98	46.82	75.44	0.66	2.69	11.49	46.78	2.13	8.67	5.73	23.33	4.55	18.53	134	546
	1406	——	29.89	21.61	48.50	74.37	0.89	3 47	12.86	50.18	1.35	5 27	3.03	11.82	7.50	29 26	156	609
	1130	——	36.28	17.16	46.55	66.77	0.85	2.56	15.38	46.28	1.72	5.18	8.00	24.07	7.28	21.91	180	542
	1009	——	34.49	16.06	49.45	65.95	1.06	3.11	13.97	41.03	2.23	6.75	6.87	20.18	9.92	29.13	180	529
	1365	——	24.32	15.60	60.07	70.12	0.95	3.18	14.12	47.26	1.78	5.96	4.56	15.26	8.47	28.35	173	579
	971	——	29.01	20.30	50.69	66.44	0.75	2.24	20.68	61.62	2.02	6.02	4.05	12.07	6.06	18.06	227	676
Average	1195	——	31.85	17.79	50 35	69.85	0.86	2.88	14.75	48.86	1.87	6.31	5 37	17.79	7.30	24.21	175	580
III. (*b*) Makapuno—Two layers (soft and hard)	1002	——	26.42	20.02	53.56	68.93	0.81	2.61	17.31	55.71	1.47	4.73	5.08	16.35	6.40	20.60	193	621
	1081	——	20.64	21.66	57.70	58.17	0.89	2.13	20.56	49.15	3.25	7.77	5.37	12.84	11.76	28.11	253	605
	1216	——	30.20	28.22	41.58	64.64	0.67	1.89	16.78	47.45	2.19	6.19	5.22	14.76	10.50	29.69	208	588
	1100	——	25.75	23.30	50.95	63.91	0.79	2.21	18.22	50.77	2.30	6.23	5.22	14.65	9.55	26.13	218	605
III. (*c*) Makapuno—One layer (hard)	1024	——	32.62	19.33	48.05	51.95	1.19	2.48	19.81	41.23	2.47	5.14	12.62	26.26	11.96	24.89	243	506
General Average	1150	——	30.11	19.69	50 30	66.28	0.87	2.64	16.30	48.67	2.06	6.17	6.05	17.69	8.44	24.85	195	580

A STUDY OF THE ASH AND CALCIUM OXIDE CONTENT IN RELATION TO SUCROSE AND GLUCOSE DECOMPOSITION IN LOW GRADE MASSECUITE[1]

JULIAN GOMERI

Previous investigators have found that sucrose in low grade massecuite undergoes a certain amount of decomposition during the time it is held in the crystallizer for crystallization. A study of the possible cause or causes of such decomposition is of importance in chemical control work as it may suggest some basis upon which a technique can be developed for the partial elimination of such loss, thereby increasing the recovery of the factory.

Salts of some alkaline earth metals are involved in the process of cane sugar manufacture. While other constituents of the ash are not well under the control of the chemist, the amount of lime, or calcium oxide added can be regulated. The necessity for some information as to the influence of the ash and calcium oxide in the destruction of sucrose in one phase of the manufacture of cane sugar led to the undertaking of the investigation reported in this paper.

REVIEW OF LITERATURE

Very little information is available in literature as to the nature of the disturbances occurring in second massecuite during crystallization. Salinas (1928), in Cuba, concluded, after a preliminary investigation based upon apparent purities, glucose, and pH determination, that crystallizers favored the forming of glucose. His conclusion seemed to indicate that sucrose was rapidly destroyed by inversion.

Jamora (1929), worked on a number of crystallizers in the factory of a Philippine sugar central during the last part of the 1929 milling season. His results showed that sucrose was destroyed during cooling in crystallizers, and that glucose was formed in some cases and destroyed in others. He also found that the pH of the massecuite decreased during cooling, indicating that acids were formed. No relationship, however, between the amount of loss of glucose and sucrose seemed to exist. From his experiments, he concluded that sucrose and glucose destruction was related inversely to the rapidity of cooling.

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Beveridge (1919), in Hawaii, after some experiments on second massecuite, concluded that there is little if any loss of sucrose in crystallizers when the massecuites have been boiled at low temperature.

It is generally known that salts of such metals as sodium, potassium, magnesium, calcium, iron and aluminum when heated with solutions of sucrose, invert the sucrose. Browne (1912) explained this reaction as a result of acid inversion, the hydrogen ion being formed by a hydrolysis of the salt in presence of water. Salts appear to act as a sort of catalyst supplying H^+, and do not directly take part in inversion. Citing Prinsen Geerligs, Browne shows that the inverting power of salts is increased by the presence of reducing sugars. Deerr (1921), who made a study of the question, came to the conclusion that the combined influence of invert sugars and neutral salts does not produce inversion, when the salts are present in normal concentration.

OBJECTS, TIME AND PLACE OF THE PRESENT WORK

The present investigation was undertaken to determine: (1) the loss of sucrose in low grade massecuite during crystallization; (2) the loss or increase of glucose; and (3) whether the amount of ash and its calcium oxide constituent bears any relation to the decomposition of sucrose and glucose.

This investigation was carried out in the factory of a Philippine sugar central, and in the sugar laboratory of the College of Agriculture, University of the Philippines, from November, 1929, to May, 1930.

MATERIALS AND METHODS

Materials used

Samples of low grade massecuites dropped into crystallizers for crystallization were obtained at varying periods of time and brought to the Central laboratory for analysis.

Sampling

Samples for sucrose and glucose analyses were obtained as follows: As a strike of low grade massecuite was being dropped into the crystallizer a sufficient quantity of the material was taken from the first portion of the strike to fill one-third of a five gallon lagged can; about the same quantity of material was taken from the middle portion of the strike and put into the can; from the last portion of the strike, about the same quantity of the material was taken; this almost filled the can. A lagged can was used so as to prevent a drop in temperature during the sampling. This sample, about five gallons, was thoroughly mixed and an aliquot of about 300 grams was taken for analysis. The temperature of the massecuite at strike was observed and the time of sampling noted.

Three or four hours later another five gallon composite sample was obtained from the crystallizer, the temperature noted, and an aliquot of about 300 grams taken from the thoroughly mixed sample. Samples were obtained at intervals of 3, 4 and 5 hours for the first day, and once a day thereafter until the massecuite was discharged into the mixer. The exact time of the different samplings are given in tables 1 to 29.

A number of crystallizers were sampled only two times, once at the time of strike, and once when the massecuite was ready to be discharged into the mixer.

Analysis of ash and of calcium oxide was made on the first samples only. There is no destruction of ash constituents, so it can be safely assumed that the ash content of the massecuite in the beginning is the same as at the end of the experiment.

Sucrose determination

The sucrose was determined by Walker's inversion method. The Brix was found by the use of the Brix spindle. The gravity purity was obtained by dividing sucrose by the corrected Brix.

Temperature corrections for the observed Brix were taken from table 2 of the *Methods of Chemical Control for Cane Sugar Factories* (1924).

Glucose determination

Glucose was determined by the methylene blue method as developed by Eynon and Lane (1923). A detailed description of this method is given in the compilation of committee reports for the Fifth Annual Convention of the Philippine Sugar Association (1927), pages 231 to 235.

Ash determination

Ash was determined by direct incineration, also known as "normal", or "carbonated" ash method. The method is described in Spencer and Meade (1929).

RESULTS AND DISCUSSION

Twenty-nine crystallizers containing low grade massecuites made during the 1929-30 milling season at a Philippine sugar central factory were placed under investigation. Analyses were performed at close intervals of time on 17 crystallizers to get the relative sucrose destruction during the early and the later periods of crystallization. Other crystallizers were analyzed at the time of strike, and when emptied into the mixer, to get the total drop in gravity purity during crystallization. The results of the analysis are shown in tables 1 to 29.

Twenty-one crystallizers investigated had ash and calcium oxide analysis on first samples. The results of these analyses are shown in table 31. The data obtained from the twenty-one crystallizers analyzed gave sufficient indication of a negative relation; analysis of the eight other crystallizers was not considered necessary.

The results are presented in tables 1 to 31.

The analytical data presented in tables 1 to 29 show that in all cases sucrose was destroyed during the time the crystallizers were under observation. In some cases, there appeared some increase in both sucrose and glucose during the progress of the experiments, but the contents, at the end were generally lower than at the beginning. The analyses at close intervals show that the destruction of sucrose and glucose was more pronounced during the early period of crystallization than during the later. No equilibrium seemed to exist between the sucrose and the glucose in the massecuite. This is shown by the increasing value of the sucrose-glucose ratio.

From these indications it can be said that crystallizers are not necessarily glucose formers. Some amount of inversion actually took place, but the decreasing value of the glucose content indicates that the destruction of glucose was more rapid than its formation. Jamora (1929), found that the hydrogen ion concentration of massecuite increased during crystallization. The increase in H^+ may be explained by the destruction of glucose, for the hydrogen ion, as shown by Browne (1912) is one of the products in the reaction between salts and reducing sugars.

From table 30 it may be seen that a big drop in gravity purity may take place within a short period. Crystallizers, numbers 14, 19, 21 and 27, were held for 43, 30, 30 and 54 hours, respectively, and the gravity purity drops were 1.14, 2.27, 1.72 and 1.47 per cent, respectively. The temperatures of these massecuites at strike were 72.8°, 79.2°, 75.0°, and 72.5°C. On the other hand, a small loss in sucrose may occur in massecuites held for a longer period. Crystallizers, numbers 10, 16 and 26, were held for 78, 76 and 92 hours, respectively. The gravity purity drops in these crystallizers were 0.12, 0.26 and 0.45, and the temperatures at strike were 70.5°, 77.0° and 74.8°C., respectively. The ash in crystallizers 10 and 16, which had small gravity purity drops, was 5.31 and 4.68 per cent, respectively and the calcium oxide was 0.64 and 0.51 per cent. Crystallizers 19 and 21, which had large gravity purity drops, had ash content of 5.08 and 5.77 per cent, respectively, and a calcium oxide content of 0.50 and 0.54 per cent, respectively. These data indicate that the ash and calcium oxide contents of the massecuites in both groups of crystallizer were approximately the same. The ash and lime contents, therefore, were not responsible for these differences in sucrose loss.

This behavior, for which no apparent cause is indicated, may be explained, possibly, by the conditions during the boiling of these massecuites. Beveridge (1919), observed that crystallizers, the massecuites of which had been boiled at low temperature, suffered very little loss in sucrose. When massecuites are boiled at high temperature some amount of inversion and glucose destruction may occur in the pan. The massecuite, when delivered into the crystallizers, contains a considerable amount of free hydrogen ion, in which case further inversion will necessarily occur.

In other crystallizers, the loss of sucrose increased with the time. Crystallizers, numbers 6, 7, 8 and 13, which were held for 52, 24, 48 and 34 hours, had gravity purity drops of 0.27, 0.19, 0.59 and 0.27 per cent, respectively. Crystallizers, numbers 23, 24 and 28, which were held for 81, 80 and 80 hours, had gravity purity drops of 1.02, 1.44 and 1.22 per cent, respectively. Data for crystallizers held for periods of from 60 to 75 hours showed drops in gravity purity of from 0.55 to 0.88 per cent.

Table 30 also shows that the decrease in glucose content depends to some extent upon the rate of sucrose decomposition. Crystallizers, numbers 14, 19, 21 and 29, which had gravity purity drops of 1.14, 2.27, 1.72 and 1.41 per cent, had glucose decrease of 0.56, 0.45, 0.54 and 0.74 per cent, respectively. On the other hand, crystallizers, numbers 2, 5, 20 and 26, which had gravity purity drops of 0.63, 0.57, 0.88 and 0.45 per cent, had glucose loss of 0.92, 0.87, 0.91 and 0.93 per cent, respectively. These data indicate that rapid inversion occurred in some crystallizers, and where the loss in sucrose was due to rapid inversion a minimum loss of glucose could be expected. When the decrease in glucose content is great it may be due to the slow destruction of sucrose.

The calcium oxide and other constituents of the ash appear to have no relation with the rate of sucrose and glucose decomposition in low grade massecuite. Table 31 shows that the massecuites studied had a fairly uniform amount of ash and lime content. But the loss in sucrose and glucose was of varied values, from which no definite relation with the ash and calcium oxide content can be drawn. Possibly, the reaction between the salts and sugar may have proceeded to a great extent during boiling, and that only a small amount of free salts was present in the massecuites at the time they were delivered into the crystallizers. While the action of the salts in the ash upon the sugars in low grade massecuite can not be entirely disregarded, the results of this investigation show that the losses that may be attributed to the action of the salts are of slight consequence. The ash and lime content, therefore, can not be regarded as important factors in the losses occurring in low grade massecuite during crystallization.

SUMMARY AND CONCLUSIONS

1. Twenty-nine crystallizers containing low grade massecuites made at a Philippine sugar central factory during the 1929-30 milling season were studied to determine the losses in low grade massecuite. Ash and calcium oxide analyses were made on twenty-one crystallizers.

2. The analytical data obtained showed that there was some destruction in both sucrose and glucose during crystallization in motion. Both showed some increase in a number of crystallizers during the progress of the observation, but the contents at the end were generally lower than at the beginning.

3. Losses of from 1 to 2 per cent sucrose per 100 solids may occur within 30 to 50 hours after the massecuite is dropped into crystallizers; however, massecuites held in crystallizers for 75 to 90 hours may have sucrose loss of only 0.12 to 0.45 per cent. In general, time and temperature have direct influence upon sucrose loss.

4. The results obtained tend to show that glucose is destroyed faster than it is formed.

5. Neither the ash nor its calcium oxide constituent appear to have relation with the rate of destruction of sucrose and glucose in low grade massecuite during crystallization.

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TABLE 1

Temperature drop and analysis of crystallizer No. 1

HOURS IN CRYSTALIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				per cent		per cent	
0	70.0	95.10	53.64	56.40	56.82	59.75	17.22	3.2997
4	68.9	95.46	53.64	56.19	56.76	59.46	17.37	3.2677
8	66.2	95.58	53.40	55.87	56.70	59.32	17.33	3.2718
12	63.5	95.88	53.40	55.69	56.82	59.26	17.16	3.3112
24	60.0	95.88	53.40	55.69	56.76	59.20	16.79	3.3806
36	57.0	95.88	53.40	55.69	56.70	59.14	16.88	3.3590
48	54.7	95.46	32.98	55.50	56.40	59.03	16.63	3.3915
60	51.0	95.58	52.98	55.43	56.40	59.01	16.76	3.3652
70	49.0	95.64	52.98	55.40	56.34	58.91	16.16	3.4864

TABLE 2

Temperature drop and analysis of crystallizer No. 2

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				per cent		per cent	
0	73.1	96.48	55.50	57.72	58.74	60.88	15.93	3.6874
4	72.0	96.00	55.32	57.63	58.38	60.81	15.61	3.7399
8	69.3	95.76	55.08	57.51	58.14	60.71	15.41	3.7729
12	67.8	95.82	55.08	57.48	58.02	60.55	15.40	3.7675
24	63.0	95.64	54.90	57.40	57.90	60.54	15.29	3.7869
48	55.5	95.55	54.72	57.25	57.66	60.33	15.04	3.8338
60	53.0	95.46	54.72	57.32	57.60	60.34	14.97	3.8477
72	50.1	95.70	54.72	57.18	57.72	60.31	14.98	3.8531
84	49.0	95.70	54.72	57.18	57.66	60.25	15.01	3.8414

TABLE 3

Temperature drop and analysis of crystallizer No. 3

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				per cent		per cent	
0	72.5	94.68	55.68	58.81	59.04	62.36	15.01	3.9334
3	72.2	94.80	55.68	58.73	59.04	62.28	14.88	3.9677
6	70.0	94.98	55.68	58.62	59.04	62.16	14.78	3.9946
18	63.0	95.28	55.86	58.63	58.92	61.84	14.66	4.0191
30	58.3	95.28	55.86	58.63	58.86	61.78	14.68	4.0150
42	55.3	94.74	55.50	58.58	58.50	61.75	14.55	4.0206
54	52.0	95.04	55.68	58.59	58.68	51.74	14.55	4.0329
66	48.6	94.86	55.50	58.51	58.56	61.73	14.52	4.0330
78	46.8	94.80	55.44	58.48	58.50	61.71	14.46	4.0456

TABLE 4

Temperature drop and analysis of crystallizer No. 4

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				*per cent*		*per cent*	
0	69.8	95.94	58.80	61.29	60.30	62.85	15.20	3.9671
5	68.0	95.40	56.46	59.18	59.76	62.64	15.16	3.9419
10	65.2	95.88	56.64	59.07	60.00	62.58	15.30	3.9216
20	61.9	95.64	56.34	58.91	59.82	62.55	15.11	3.9590
30	58.0	95.58	56.28	58.88	59.70	62.46	14.97	3.9880
45	54.0	95.46	56.16	58.83	59.58	62.41	14.87	4.0067
55	52.3	95.34	55.98	58.72	59.46	62.37	14.80	4.0176
70	50.0	95.34	55.98	58.72	59.40	62.30	14.76	4.0244

TABLE 5

Temperature drop and analysis of crystallizer No. 5

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				*per cent*		*per cent*	
0	73.2	95.94	54.18	56.47	58.26	56.73	16.88	3.4514
5	71.2	96.36	54.36	56.41	58.24	56.69	16.77	3.4729
10	69.0	95.88	54.06	56.38	58.14	56.64	15.59	5.5045
25	64.0	95.70	53.94	56.46	57.90	56.56	16.16	3.5829
35	61.0	96.18	54.18	56.33	58.20	56.51	16.15	3.6037
50	56.0	95.82	53.94	56.29	57.90	56.43	16.08	3.6007
60	54.2	95.64	53.82	56.27	57.72	56.35	15.97	3.6143
75	51.0	95.58	53.76	56.25	57.60	56.26	15.94	3.6136
85	49.2	95.64	53.76	56.21	57.54	56.16	16.01	3.5940

TABLE 6

Temperature drop and analysis of crystallizer No. 6

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				*per cent*		*per cent*	
0	72.9	94.14	56.40	59.91	60.24	63.99	15.19	3.9658
4	70.3	94.44	56.22	59.53	60.36	63.91	15.23	3.9632
8	68.5	94.20	56.04	59.49	60.18	63.89	15.08	3.9907
24	60.0	94.20	55.98	59.43	60.12	63.82	14.79	4.0649
32	57.2	94.32	56.04	59.41	60.18	63.80	14.73	4.0855
44	51.1	94.50	56.10	59.37	60.24	63.75	14.69	4.1007
52	50.0	94.44	56.04	59.34	60.18	63.72	14.69	4.0967

TABLE 7

Temperature drop and analysis of crystallizer No. 7

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				per cent		per cent	
0	73.8	95.88	56.46	58.89	60.90	63.52	15.31	3.9778
4	71.8	96.12	56.52	58.80	61.02	63.48	15.19	4.0171
8	69.1	95.94	56.34	58.72	60.84	63.41	15.16	4.0132
24	60.8	95.88	56.28	58.70	60.72	63.33	15.19	3.9974

TABLE 8

Temperature drop and analysis of crystallizer No. 8

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				per cent		per cent	
0	69.5	97.14	57.36	59.05	61.92	63.74	14.78	4.1894
4	65.0	96.60	57.00	59.00	61.55	63.73	14.78	4.1651
8	62.0	96.78	57.00	58.90	61.62	63.67	14.77	4.1720
12	59.5	97.08	57.12	58.84	61.38	63.22	14.72	4.1698
24	51.0	97.20	57.12	58.77	61.38	63.15	14.67	4.1840
36	47.2	97.20	57.18	58.83	61.44	63.21	14.64	4.1967
48	44.0	97.20	57.12	58.77	61.38	63.15	14.64	4.1955

TABLE 9

Temperature drop and analysis of crystallizer No. 9

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				per cent		per cent	
0	70.0	97.62	55.62	56.98	60.00	61.46	14.35	4.1812
4	69.5	97.02	55.20	56.90	59.58	61.41	14.45	4.1232
8	67.2	97.38	55.38	56.87	59.76	61.37	14.21	4.2055
24	61.7	97.26	54.96	56.51	59.22	60.89	14.06	4.2119
48	53.5	96.90	54.72	56.47	58.74	60.62	13.90	4.2259
60	49.5	96.90	54.42	56.16	57.84	59.69	14.64	3.9508

TABLE 10

Temperature drop and analysis of crystallizer No. 10

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE/GLUCOSE
	°C.				*per cent*		*per cent*	
0	70.5	95.64	60.84	63.62	64.62	67.57	13.37	4.8332
78	48.0	95.76	60.59	62.72	64.59	67.45	12.96	4.9838

TABLE 11

Temperature drop and analysis of crystallizer No. 11

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE/GLUCOSE
	°C.				*per cent*		*per cent*	
0	69.0	95.70	61.47	64.23	67.41	70.44	13.25	5.0875
90	49.0	95.80	60.93	63.59	64.92	67.75	12.51	5.1894

TABLE 12

Temperature drop and analysis of crystallizer No. 12

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE/GLUCOSE
	°C.				*per cent*		*per cent*	
0	71.0	96.27	60.99	63.35	64.80	67.31	12.85	5.0428
61	52.8	95.82	60.66	63.31	63.42	66.19	12.42	5.1063

TABLE 13

Temperature drop and analysis of crystallizer No. 13

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE/GLUCOSE
	°C.				*per cent*		*per cent*	
0	77.5	97.20	61.47	63.24	65.67	67.56	13.08	5.0206
34	57.0	96.66	61.38	63.50	65.04	67.29	12.99	4.9725

TABLE 14

Temperature drop and analysis of crystallizer No. 14

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				*per cent*		*per cent*	
0	72.8	96.90	61.02	63.17	65.04	67.33	13.50	4.8178
44	51.8	96.45	60.39	62.61	63.84	66.19	12.94	4.9335

TABLE 15

Temperature drop and analysis of crystallizer No. 15

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				*per cent*		*per cent*	
0	78.0	96.96	58.86	60.71	63.42	65.41	14.06	4.5107
49	56.0	97.05	58.65	60.43	63.06	64.98	13.80	4.4851

TABLE 16

Temperature drop and analysis of crystallizer No. 16

HOURS IN CRYSTALLIZER	TEMPERA TURE	BRIX	POLARIZATION	APPARENT-PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				*per cent*		*per cent*	
0	77.0	97.56	60.36	61.87	64.62	66.24	14.08	4.5895
76	50.2	97.53	60.15	61.67	64.35	65.98	13.94	4.6162

TABLE 17

Temperature drop and analysis of crystallizer No. 17

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	$\frac{\text{SUCROSE}}{\text{GLUCOSE}}$
	°C.				*per cent*		*per cent*	
0	77.4	97.26	58.80	60.46	63.24	65.02	14.11	4.4819
70	51.5	97.20	57.90	59.57	62.37	64.17	13.72	4.5459

TABLE 18

Temperature drop and analysis of crystallizer No. 18

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	78.5	97.32	57.84	59.43	62.40	64.12	14.08	4.4318
35	62.5	97.38	57.06	58.60	61.92	63.59	13.54	4.5731

TABLE 19

Temperature drop and analysis of crystallizer No. 19

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	79.2	96.90	64.74	66.81	66.00	68.11	12.83	5.1441
6	74.0	96.72	61.08	63.15	64.92	67.12	13.11	4.9519
18	69.0	96.90	60.48	62.41	64.74	66.81	12.49	5.1833
30	63.5	96.78	60.06	62.06	63.72	65.84	12.38	5.1470

TABLE 20

Temperature drop and analysis of crystallizer No. 20

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	79.2	96.42	60.96	63.22	64.74	67.15	13.23	4.8934
4	77.0	96.90	61.20	63.16	65.04	67.12	13.07	4.9762
8	75.0	96.90	61.20	63.16	65.04	67.12	12.89	5.0458
12	73.0	96.96	60.96	62.87	65.04	67.08	12.80	5.0812
24	68.2	96.60	60.90	63.04	64.68	67.00	12.51	5.1703
36	63.0	96.78	60.24	62.24	64.50	66.65	12.45	5.1807
48	58.8	96.96	60.24	62.25	64.50	66.52	12.38	5.2100
60	54.2	96.78	59.82	61.81	64.14	66.27	12.32	5.2062

TABLE 21

Temperature drop and analysis of crystallizer No. 21

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	75.0	96.72	57.75	59.71	62.22	64.33	14.48	4.2969
30	50.0	96.60	57.00	59.00	60.48	62.61	13.94	4.3385

TABLE 22

Temperature drop and analysis of crystallizer No. 22

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	73.0	95.88	59.46	62.02	63.60	66.33	13.64	4.6627
24	62.7	96.30	59.46	61.73	63.60	66.05	13.30	4.7819
48	56.8	96.24	58.86	61.16	63.06	65.52	13.17	4.7882
60	51.6	96.36	58.86	61.08	60.12	65.48	13.01	4.8516
72	49.5	96.24	58.86	61.16	63.00	65.46	12.97	4.8574

TABLE 23

Temperature drop and analysis of crystallizer No. 23

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	74.0	96.12	60.06	62.48	64.08	62.48	13.69	4.6808
81	52.0	96.06	59.04	61.46	63.60	61.46	12.91	4.9264

TABLE 24

Temperature drop and analysis of crystallizer No. 24

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C				*per cent*		*per cent*	
0	73.0	96.60	58.26	60.31	62.28	64.47	14.70	4.2367
4	69.3	96.48	58.08	60.20	61.80	64.05	14.63	4.2242
8	67.0	96.42	58.08	60.24	61.80	64.05	14.42	4.2857
20	61.0	96.48	57.48	59.76	61.80	64.05	14.27	4.3308
32	59.0	96.24	57.42	59.67	61.50	63.91	14.15	4.3463
44	56.2	96.30	57.36	59.56	61.44	63.80	14.00	4.3886
56	54.0	96.66	57.24	59.22	61.38	63.50	13.98	4.3906
68	52.0	96.84	57.24	59.11	61.14	63.14	13.96	4.3796
80	50.3	96.72	57.24	59.18	60.96	63.03	13.92	4.3793

TABLE 25

Temperature drop and analysis of crystallizer No. 25

HOURS IN CRYSTAL-LIZER	TEMPERA-TURE	BRIX	POLARIZA-TION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	74.8	97.44	58.25	59.79	68.34	70.14	14.52	4.7066
98	46.0	97.32	57.18	58.75	67.44	69.30	13.71	4.9190

TABLE 26

Temperature drop and analysis of crystallizer No. 26

HOURS IN CRYSTAL-LIZER	TEMPERA-TURE	BRIX	POLARIZA-TION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	74.8	97.62	58.68	60.11	62.58	64.11	14.65	4.2717
4	73.1	97.62	58.56	59.99	62.58	64.11	14.46	4.3278
8	71.4	97.68	58.20	59.58	62.52	64.00	14.24	4.4372
20	66.0	97.68	58.02	59.40	62.46	63.94	14.09	4.4329
32	62.0	97.67	58.02	59.40	62.46	63.94	13.87	4.5032
44	58.2	97.38	57.84	59.40	62.40	64.08	13.68	4.5614
56	55.0	97.62	58.02	59.43	62.40	63.92	13.70	4.5547
68	51.5	97.62	57.90	59.31	62.46	63.86	13.72	4.5525
80	49.2	97.74	57.90	59.24	62.40	63.84	13.72	4.5481
92	47.0	97.74	57.78	59.12	62.22	63.66	13.72	4.5350

TABLE 27

Temperature drop and analysis of crystallizer No. 27

HOURS IN CRYSTAL-LIZER	TEMPERA-TURE	BRIX	POLARIZA-TION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				*per cent*		*per cent*	
0	72.5	97.86	57.18	58.61	62.04	63.40	15.28	4.0602
3	72.2	98.04	57.36	58.51	62.04	63.28	15.30	4.0549
6	71.0	98.10	56.94	58.04	61.92	63.12	15.21	4.0710
18	66.0	98.10	56.04	57.10	61.02	61.20	15.08	4.0464
30	61.5	98.16	56.04	57.09	60.72	61.86	14.87	4.0834
42	58.0	98.04	55.86	56.98	60.72	61.93	14.67	4.1391
54	54.5	98.04	55.74	56.85	60.72	61.93	14.44	4.2049

TABLE 28

Temperature drop and analysis of crystallizer No. 28

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				per cent		per cent	
0	71.5	97.50	58.20	59.72	62.52	64.12	14.90	4.1960
4	68.8	97.38	58.02	59.58	62.40	64.07	14.68	4.2507
8	67.5	97.38	58.02	59.58	62.34	64.02	14.49	4.3023
20	63.0	97.38	57.96	59.52	62.34	64.02	14.33	4.3503
32	59.0	97.26	57.84	59.47	62.22	63.97	14.16	4.3941
44	55.0	97.38	57.54	59.09	62.10	63.77	14.15	4.3887
56	51.0	97.44	57.36	58.87	61.44	63.05	14.11	4.3544
68	50.5	97.38	57.06	58.60	61.32	62.97	14.09	4.3520
80	49.5	97.38	56.82	58.35	61.26	62.92	14.08	4.3509

TABLE 29

Temperature drop and analysis of crystallizer No. 29

HOURS IN CRYSTALLIZER	TEMPERATURE	BRIX	POLARIZATION	APPARENT PURITY	SUCROSE	GRAVITY PURITY	GLUCOSE	SUCROSE / GLUCOSE
	°C.				per cent		per cent	
0	74.0	96.12	54.90	57.12	59.28	61.67	14.98	3.9573
4	73.0	96.30	54.90	57.00	59.34	61.63	14.95	3.9692
8	70.0	96.48	54.54	56.53	59.10	61.26	15.00	3.9400
20	63.5	96.42	54.42	56.44	59.04	61.23	14.94	3.9518
32	61.0	96.12	54.18	56.37	58.50	60.86	14.59	4.0096
44	57.2	96.12	53.88	56.05	58.02	60.36	14.37	4.0376
56	54.5	96.18	53.70	55.83	57.96	60.26	14.24	4.0702

TABLE 30

Showing the total number of hours in crystallizers, the temperature, gravity purity, glucose and sucrose-glucose ratio at the beginning and end, and the temperature drop, gravity purity drop and glucose loss

CRYSTALLIZER NO.	HOURS IN CRYSTALLIZERS	TEMPERATURE	GRAVITY PURITY	GLUCOSE	TEMPERATURE DROP	GRAVITY PURITY DROP	GLUCOSE LOSS	SUCROSE / GLUCOSE
		°C.		*per cent*	°C.		*per cent*	
1	0	70.0	59.75	17.22	21.0	0.84	0.61	3.2997
	72	49.0	59.81	16.61				3.2677
2	0	73.1	60.88	15.98	24.1	0.63	0.92	3.6874
	84	49.0	60.25	15.01				3.8414
3	0	72.5	62.36	15.01	25.7	0.65	0.55	3.9334
	78	46.8	61.71	14.46				4.0456
4	0	69.8	62.85	15.20	19.8	0.55	0.44	3.9671
	70	50.0	62.30	14.76				4.0244
5	0	73.2	56.73	16.88	24.0	0.57	0.87	3.4514
	85	49.2	56.16	16.01				3.5940
6	0	72.9	63.99	15.19	22.9	0.27	0.50	3.9658
	52	50.0	63.72	14.69				4.0967
7	0	73.8	63.52	15.31	13.0	0.19	0.12	3.9778
	24	60.8	63.33	15.19				3.9974
8	0	69.5	63.74	14.78	25.5	0.59	0.15	4.1894
	48	44.0	63.15	14.63				4.1955
9	0	70.0	61.40	14.35	20.5	0.77	0.29	4.1812
	60	49.5	59.69	14.64				3.9508
10	0	70.5	67.57	13.37	22.5	0.12	0.41	4.8332
	78	48.0	67.45	12.94				4.9838
11	0	69.0	70.44	13.25	20.0	2.69	0.74	5.0875
	90	49.0	67.75	12.51				5.1894
12	0	71.0	67.31	12.85	18.2	1.12	0.43	5.0428
	61	52.8	66.19	12.42				5.1063
13	0	77.5	67.56	13.08	20.5	0.27	0.09	5.0206
	34	57.0	67.29	12.99				4.9725
14	0	72.8	67.33	13.50	21.0	1.14	0.56	4.8178
	43	51.8	66.19	12.94				4.9335
15	0	78.0	65.41	14.08	22.0	0.43	0.26	4.5107
	49	56.0	64.98	13.80				4.4851

TABLE 30—(Continued)

Showing the total number of hours in crystallizers, the temperature, gravity purity, glucose and sucrose-glucose ratio at the beginning and end, and the temperature drop, gravity purity drop and glucose loss

CRYSTALLIZERS NO.	HOURS IN CRYSTALLIZERS	TEMPERATURE	GRAVITY PURITY	GLUCOSE	TEMPERATURE DROP	GRAVITY PURITY DROP	GLUCOSE LOSS	SUCROSE / GLUCOSE
		°C.		*per cent*	°C.		*per cent*	
16	0	77.0	66.24	14.08	26.8	0.26	0.14	4.5895
	76	50.2	65.98	13.94				4.6162
17	0	77.4	65.02	14.11	25.9	0.85	0.38	4.4918
	70	51.5	64.17	13.72				4.5459
18	0	78.5	64.12	14.08	16.0	0.55	0.54	4.4318
	35	62.5	63.59	13.54				4.5731
19	0	79.2	68.11	12.83	15.7	2.27	0.45	5.1441
	30	63.5	65.84	12.38				5.1470
20	0	79.2	67.15	13.23	25.0	0.88	0.91	4.8934
	60	54.2	66.27	12.32				5.2062
21	0	75.0	64.33	14.48	16.0	1.72	0.54	4.2969
	30	59.0	62.61	13.94				4.3385
22	0	73.0	66.33	13.64	23.5	0.87	0.67	4.6627
	72	49.5	65.46	12.97				4.8574
23	0	74.0	62.48	13.60	22.0	1.02	0.78	4.6808
	81	52.0	61.46	12.91				4.9264
24	0	73.0	64.47	14.70	22.7	1.44	0.78	4.2367
	80	50.3	63.03	13.92				4.3793
25	0	74.8	70.14	14.52	28.8	0.84	0.81	4.7066
	98	46.0	69.30	13.71				4.9190
26	0	74.8	64.11	14.65	27.8	0.45	0.93	4.2717
	92	47.0	63.66	13.72				4.5350
27	0	72.5	63.40	15.28	18.0	1.47	0.84	4.0602
	54	54.5	61.93	14.44				4.2049
28	0	71.5	64.12	14.90	22.0	1.22	0.82	4.1960
	80	49.5	62.90	14.08				4.3509
29	0	74.0	61.67	14.98	29.5	1.41	0.74	3.9573
	56	54.5	60.26	14.24				4.0702

TABLE 31

Showing the ash and its calcium oxide at the beginning, and the loss in gravity purity and glucose during crystallization

CRYSTAL-LIZERS NO.	GRAVITY PURITY LOSS	GLUCOSE LOSS	$\frac{\text{ASH}}{100 \text{ BRIX}}$	$\frac{\text{CaO}}{100 \text{ BRIX}}$
		per cent		
1	0.84	0.61	6.19	0.50
2	0.63	0.92	6.13	0.51
3	0.65	0.65	5.61	0.56
4	0.55	0.44	5.40	0.53
5	0.57	0.87	6.76	0.79
6	0.27	0.50	5.71	0.69
7	0.19	0.12	6.02	0.64
8	0.59	0.71	7.24	0.67
10	0.12	0.41	5.31	0.64
11	2.69	0.74	4.73	0.44
12	1.12	0.43	5.04	0.46
13	0.27	0.09	5.73	0.48
15	0.43	0.26	5.69	0.53
16	0.26	0.14	4.68	0.51
17	0.85	0.39	6.15	0.52
19	2.27	0.45	5.08	0.50
20	0.88	0.91	5.07	0.59
21	1.72	0.54	5.77	0.54
22	0.87	0.67	7.70	0.50
82	1.22	0.82	5.50	0.47
92	1.41	0.74	5.85	0.49

WEEDS IN RICE PADDIES: GERMINATION OF SEEDS AND RESISTANCE OF THE YOUNG PLANTS TO SUBMERGENCE IN WATER[1]

MARCELINO B. GARCIA

WITH SEVEN TEXT FIGURES

Weeds are always abundant in the fields in the Philippine Islands. They grow with the cultivated plants and usually cause injury to them. Weeds compete with crop plants, such as rice, sugar cane, and corn, for food, water, light, and air. They prevent the crops from attaining complete development and giving a maximum yield. They harbor insects, bacteria and fungus enemies of the crop plants, and their presence in the fields hinders in the harvesting and curing of crops.

For these reasons, knowledge of the germination and subsequent growth and development of weeds is important in connection with farming. The present study deals with the common rice paddy weeds, germination of their seeds, and resistance of the young plants to submergence in water. The main objective was to determine the conditions that might cause the failure of the weed seeds to germinate and the depth of water in the paddy fields that might kill or smother the weed plants.

Knowledge on the subject of weeds in the Philippines is very limited. There is little literature on the subject available. Reports of studies on weeds in the United States are not applicable to Philippine conditions as they deal with weed plants of different species.

Dunshee (1928)[2] working on weed control in the Sacramento Valley, California, reports that continuous submergence to depths of 6 to 8 inches after the rice is sown broadcast will satisfactorily control most of the various types of water grass, *Echinochloa crusgalli* and the sprangle top, *Leptochloa fascicularis*. The author, however, states that this method will not control the late white water grass, which matures its seed in September and October. The only known method of control of this weed is to pull it up as it appears in the field. Dunshee reports also that sedge, *Cyperus difformis*, red stem, *Ammania coccinea*, arrow-head, *Sagittaria latifolia*, and the water plaintain, *Alisma plantago* can usually be controlled satisfactorily with a thick stand of rice which has been planted as early in the spring as possible. He believes that in order to insure a thick stand of rice, at least 150 pounds of well matured seed should be sown on a smooth seed bed. The cat-tail, *Typha latifolia* can be controlled satisfactorily by plowing the soil each spring and allowing the roots to dry; joint grass, *Paspalum districhum*, can be controlled by fallowing for a year or two, and the wire grass or spike rush, *Eleocharis palustris*, by thorough plowing in the spring.

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[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Agriculture, from the College of Agriculture No. 397; Experiment Station contribution No. 737. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

[2] Dunshee, C. F. 1928. Rice experiments in Sacramento Valley 1922-1927. California Agric. Exper. Sta. Bull. 454: 1–14.

Hernandez (1923)[3] reports on results of observations on the behavior of weeds in the Philippines. He reports that deep submergence in water in rice fields (15 to 20 cm.) was effective in controlling a number of common weeds, such as *Eleocharis capitata*, *Cyperus difformis* and other species, although it seemed to delay somewhat the maturity of the rice crop.

Owing to the importance of the weed plants in connection with rice growing, and the limited knowledge on the subject of weed control, it was deemed worth while to determine (*a*) the influence of moisture in pots on the germination of weed seeds; (*b*) the influence of the amount of water in pots on the growth and development of weed plants; and (*c*) the resistance of the young weed plants to submergence in water.

This study was carried out in the Department of Plant Physiology, College of Agriculture, University of the Philippines, Los Baños, Laguna. The experiments were begun in June, 1929 and concluded in February, 1930.

MATERIALS AND METHODS

The weed plants

In this study, seeds and young plants of six kinds of common rice paddy weeds were used:

Panicum crusgalli, Linn. Gramineae
Eclipta alba, Linn. Compositae
Cyperus difformis, Linn. Cyperaceae
Cyperus pilosus, Vahl. Cyperaceae
Cyperus iria, Linn. Cyperaceae
Fimbristylis annua, (All) R. & S. Cyperaceae

As seeds of *Panicum crusgalli*, *Cyperus difformis*, *Cyperus iria*, *Cyperus pilosus* and *Fimbristylis annua* (formerly called *F. diphylla* (Retz) Vahl.) were not obtainable from the College Farm in June, 1929, seeds of these weeds were gathered in rice fields in Calamba, Laguna.

Except the *Panicum crusgalli* these seeds were prepared for use in this study by drying the matured inflorescences in the sun. When sufficiently dry, the inflorescences were rubbed between the palms thus reducing them into a mixture of hull and seeds. This mixture was put into a vessel of water and stirred once or twice. Only the seeds that settled to the bottom of the vessel were saved for use.

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[3] Hernandez, A. 1923. Philippine Bureau of Agriculture Annual Report 23: 77–119; 129–134.

Panicles bearing matured seeds of *Panicum crusgalli* were dried in the sun. When sufficiently dry, the panicles were rubbed between the palms to separate the seeds from other parts. Only the seeds that were dark-gray or gray in color were saved for use; those that were white were discarded.

Capsules containing matured seeds of *Eclipta alba* were collected from rice fields. These capsules were dried in the sun. Then they were rubbed between the palms until the seeds dropped off and were easily separated from other parts. Care was taken that only the larger and well developed seeds were used; the smaller seeds, that is, those that appeared undeveloped, were discarded.

The soil used

Fine sand was used as the germinating medium in this study. The sand was collected from the banks of Molawin Creek, near the Landscape Garden of the College, where it had been deposited by the running water. It was sifted in a sieve with one-mm. mesh. The sifted sand was sterilized by heating it to about 100°C. This precaution was taken in order to kill the seeds of other weeds that might have been mixed with the sand. Sterilization also would kill fungi and bacteria in the soil that might harm the weed seeds and seedlings.

Besides the sand, clay-loam soil was also used. The clay-loam soil was collected from rice fields in the College Experiment Station and brought to the laboratory. It was pulverized well and placed in pots.

Germination of seeds as influenced by moisture in soil

In the germination of the seeds as influenced by moisture in the soil, porcelain tumblers of 1000 cc. capacity each were used as germination receptacles. The weight of each receptacle and of the sand together with the weight of the moisture in it formed the initial weight of the culture. The germination receptacles were grouped into eleven lots. Each lot was treated in such a way that the moisture content of the sand in lot I was 10 per cent of water saturation; in lot II, 20 per cent; in lot III, 30 per cent; in lot IV, 40 per cent; in lot V, 50 per cent; in lot VI, 60 per cent; in lot VII, 70 per cent; in lot VIII, 80 per cent; in lot IX, 90 per cent; in lot X, 100 per cent, and supersaturation in lot XI. In lot XI, the excess water was about 0.5 to 1 cm. above the surface of the soil.

In determining the moisture content of the soil, a method similar to that employed by Ventura (1929)[4] was followed. Four hundred grams of the soil were put in a glass funnel. A known volume of tap water was poured into it, the excess amount was caught in a beaker. The excess amount was subtracted from the original volume and the difference was the amount added to the soil. This amount of water and the original small amount of water in the almost air-dry soil constituted the total amount of water in the soil. The soil in this state of saturation was arbitrarily considered 100 per cent. The 90 per cent water saturation was determined by adding to the quantity of soil 90 per cent of the water that gave 100 per cent saturation. The other percentages of saturation,—80, 70, 60, 50, 40, 30, 20, and 10, were separately and similarly determined.

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[4] Ventura, Gaudencio A. 1929. Studies on the germination of vegetable seeds. The Philippine Agriculturist **17**: 451–463.

One hundred seeds of each of the six kinds of weeds used were spread on the surface of the sand in each germination receptacle and carefully covered with sand to a depth of about 3 mm. The required amounts of water to make up the different percentages of saturation were separately and carefully added to the pots and these amounts (or rather percentages of saturation) were maintained throughout the course of the experiment, by putting back every day an amount of water equal to the amount evaporated, or lost from each pot.

The effect of the amount of water in pots on the growth and development of weeds

In this study, kerosene cans containing clay-loam soil were used. These pots were supplied with water in the following amounts: (*a*) the soil was just moist (about 50 per cent water saturation); (*b*) the soil was saturated in water; (*c*) the water on the surface of the soil was 5 cm. deep; and (*d*) water 10 cm. in depth. Holes were made in the sides of the cans at the proper heights above the soil so that whatever amount of water was in excess would drain out. Water was added to the cultures whenever needed; the weed plants were grown in these cultures to maturity.

Effect of submergence in water

Weed seeds were germinated in sand. When the seedlings were about 2.5 cm. tall, they were transplanted to porcelain tumblers of 1000 cc. capacity each, containing clay-loam soil. Only young weed plants of almost uniform development were used in this experiment. When the young plants were quite well rooted in the soil in the pots, water to a depth of 15 cm. was added to some pots; while the others were given as much as to make 10 cm. above the surface of the soil. Thus, the young weed plants, although rooted in the soil, had their tops entirely submerged in the water. These depths of water were maintained throughout the experiment.

EXPERIMENTS AND RESULTS

Germination of weed seeds as influenced by moisture

The first trials to germinate seeds of each of the six kinds of weeds in tumblers containing fine sand, supplied with water of different amounts, were made in a room in the Laboratory of Plant Physiology. Unfortunately, only very few seeds germinated, hence the data thus gathered were discarded. The failure of the seeds to germinate may have been due to too low temperature of the air or to too little light. The subsequent germination experiments, using the seeds from the same supply, were made outside where the cultures could be exposed to light and to warm air on bright sunny days. A sliding nipa roof was placed over the cultures when it rained. These trials were quite successful; the weed seeds germinated readily. Two germination trials were made of seeds of each kind of weeds studied, and the data obtained from these experiments were recorded in table 1[5]. The average percentages of germination shown in table 1 were converted into their corresponding *relative values.* The latter data are shown in table 2. Seedlings of *Panicum crusgalli* five weeks old, grown in these experiments were photographed, to show their relative state of development as influenced by the amount of moisture in the soil (see figure 1).

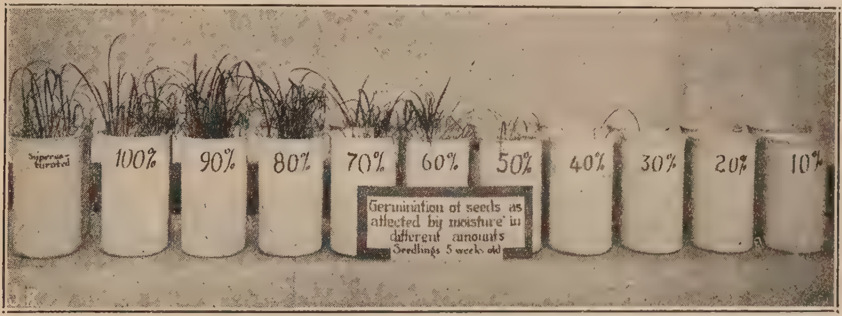

Fig. 1.—Young weed plants, *Panicum crusgalli* Linn., grown for five weeks in sand containing different amounts of moisture.

Effect of water on germination of seeds and subsequent growth and development of weed plants

The first set of experiments under this problem was carried out as described under "Materials and Methods," from September 10 to December 4, 1929. Twenty-four germination tests were made, four for each of the six kinds of weeds studied. One hundred seeds of each kind of weed were sown in each germination receptacle, hence, 400 seeds of each kind of weed were sown at the same time. After sowing, the seeds were covered with clay-loam soil to a depth of about 2 mm. Then the required amounts of water were slowly and carefully added to the pots and these amounts were kept constant throughout the course of these experiments by adding water from time to time, to replace the loss of water from the pots. Four conditions of saturation of the soil were maintained; namely, (*a*) moist soil, (*b*) soil saturated with water, (*c*) water 5 cm. above the surface of the soil, and (*d*) water 10 cm. above the surface of the soil.

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[5] Table 1 is not included here; it is on file in Department of Plant Physiology, College of Agriculture.

On reaching maturity, the plants in each germination pot were photographed, (see figures 2a, 2b, 2c, 2d, and 2e). Then, after the data on the following criteria had been gathered, the plants were harvested:

(*a*) Number of days to complete life cycle.
(*b*) Height of plants.
(*c*) Percentage of maturity.

These data are presented in table 3.

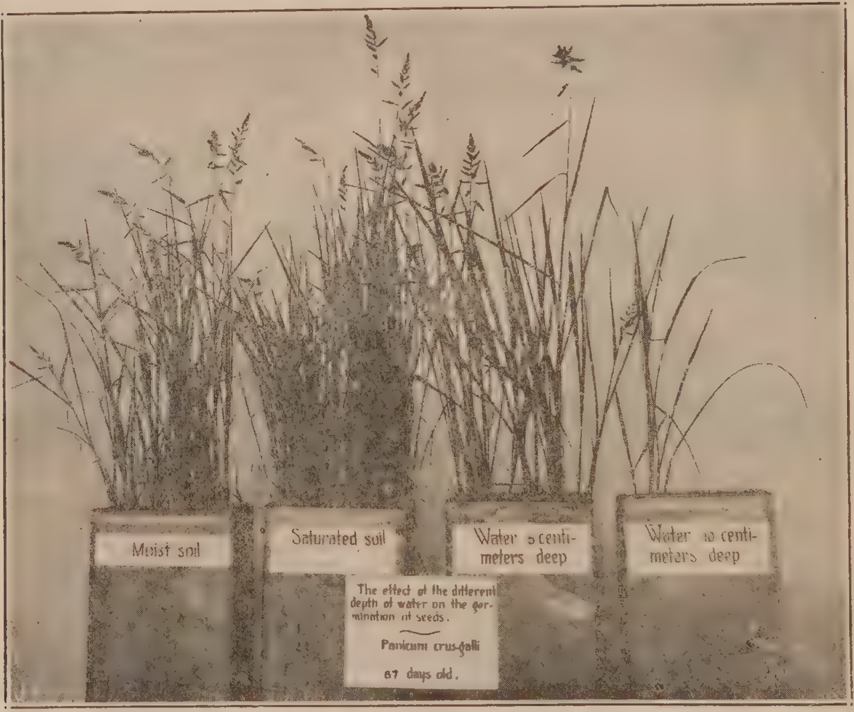

Moist soil
Saturated soil
Water 5 centimeters deep
Water 10 centimeters deep
The effect of the different depth of water on the germination of seeds.
Panicum crus-galli
87 days old.

Fig. 2a.—Weeds, *Panicum crusgalli* Linn., grown in clay-loam soil in pots containing water in different amounts. The cultures were grown in the pots from September 10, 1929 to December 4, 1929.

Effect of submergence in water

The experiments on the effects of submerging young weed plants (grown in clay-loam soil in pots) in water 10 and 15 cm. above the surface of the soil in pots were begun on October 19, 1929 and ended on February 15, 1930. The experiments were conducted as described under "Materials and Methods", outside the building, directly exposed to the sun and rain.

Frequent visits to the cultures were made to note the condition of the plants as they were submerged in the water. The plants that survived the effects of submergence were counted twice during the progress of this study. The first counting was made when the plants had been in the water for about 35 days, and the second counting was made after about 60 days submergence.

Except *Panicum crusgalli*, which was able to emerge from 10 cm. of water, the cultures remained submerged. For these reasons, only *Panicum crusgalli* plants were photographed (see fig. 3). Before closing these experiments, the living plants in each culture were counted and the data obtained together with other pertinent data are presented in table 5.

DISCUSSION OF RESULTS

The present study was carried out in three parts, or topics; namely, (*a*) germination of seeds as influenced by moisture in pots; (*b*) growth and development of the weed plants as influenced by the amount of water in pots; and (*c*) the resistance of the young weed plants to submergence in water. The data obtained are here discussed separately for each part.

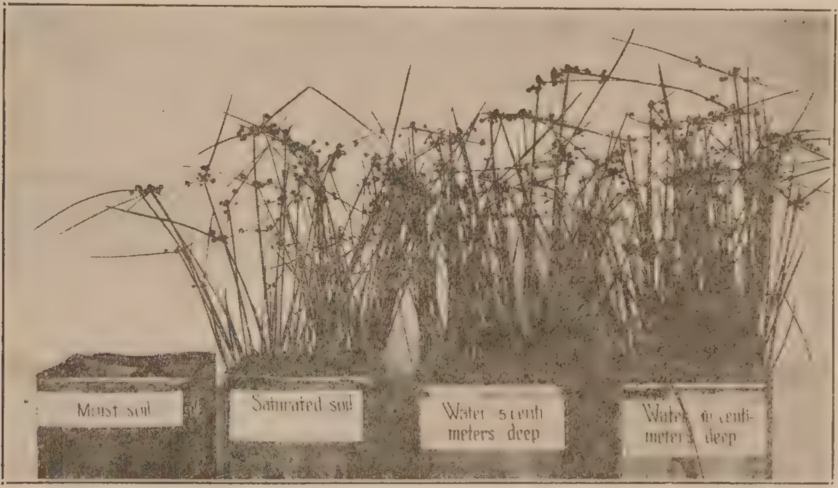


Fig. 2b.—Weeds, *Cyperus difformis* Linn., grown in clay-loam soil in pots containing water in different amounts. The cultures were grown in the pots from September 10, 1929 to December 4, 1929.

Germination of seeds of weeds as influenced by moisture in pots

Examination of the data in table 1 showed that with the proper amount of moisture in the soil, seeds of the six species of weeds began to germinate within the first week from the date of sowing. The seeds of these six species of weeds germinated rapidly and fairly equally. Most of the seeds of the five species, *Fimbristylis annua*, *Panicum crusgalli*, *Cyperus pilosus* and *C. iria*, and *Eclipta alba*, sprouted during the first week or during the first two or three weeks. The seeds of *Cyperus difformis* were later, sprouting after four weeks. With the first five species, sprouting of the seeds was found complete or practically so by the end of the fourth week.

Examination of table 2, which contains average data on percentages of germination of the seeds taken from table 1, will show that the seeds of the six kinds of weeds did not sprout when the moisture content of the germinating medium was as low as, or lower than, 30 per cent saturation. But, as the moisture content of the pot was increased there was a corresponding increase in the percentage of germination of the seeds of the six kinds of weeds. The optimal moisture content of the soil for these seeds was found to be about 100 per cent, or above. It is worthy of note that the seeds of *Panicum crusgalli* in the two trials made gave the highest record on germination in pots containing 90 per cent saturation. The 100 per cent saturation, however, and the submerged conditions of the soil were almost equally as favorable to the germination of the seeds of this weed (see fig. 1). From the foregoing discussion, it may be safe to infer or even to conclude that one way of checking the germination of the weed seeds under investigation is to keep the soil dry before it is made ready for planting. This is a suggestion, not a recommendation as no study was made as to whether or not the weed seeds would be killed if kept in a field in which the moisture content was rather low. To fill out this apparent gap in the knowledge on weed seeds and weed plants, studies should be made to determine the duration of the period of dormancy of the seeds of each of the weeds.

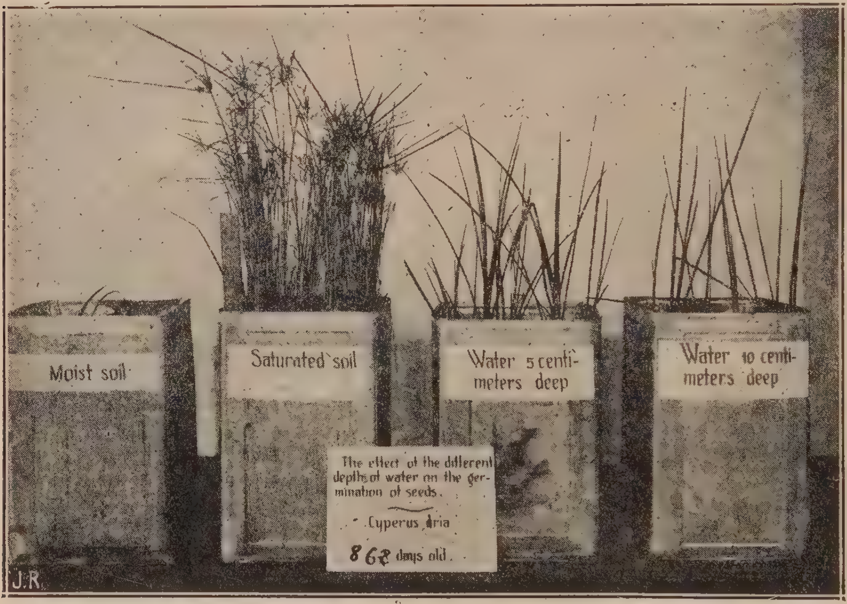

Moist soil
Saturated soil
Water 5 centimeters deep
Water 10 centimeters deep
The effect of the different depths of water on the germination of seeds.
Cyperus iria
862 days old.
J.R.

Fig. 2c.—Young weeds, *Cyperus iria* Linn., grown in clay-loam soil in pots containing water in different amounts. The cultures were grown from September 10, 1929 to December 4, 1929.

Growth and development of the weed plants as influenced by the amount of water in pots

The data in tables 3 and 4 show that the moisture in the soil influenced materially the development of the weed plants studied. Of the six kinds of weeds, *Cyperus iria, C. pilosus, Panicum crusgalli, Eclipta alba, Cyperus difformis*, and *Fimbristylis annua*, the two last named species were rather exacting in moisture requirements. These two species failed to grow when the soil was only moist. The other species were able to get along quite well even in moist soil but grew best in soil saturated in water. Saturation was found also best for the growth and development of *Cyperus difformis* and *Fimbristylis annua*. In short, all of the six species of weeds here studied developed best in soil saturated with water. With the exception of *Cyperus pilosus* and *Eclipta alba*, they were able to show resistance, or tolerance to the presence of much water in the soil. They were able to make some headway even if the water in pots was 5 or 10 cm. in depth. In these depths *Cyperus pilosus* and *Eclipta alba* died.

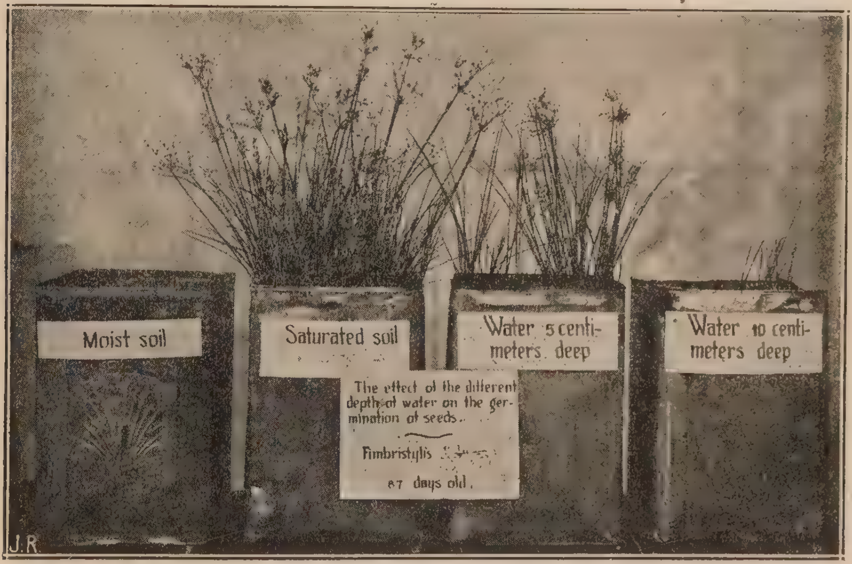

Moist soil
Saturated soil
Water 5 centimeters deep
Water 10 centimeters deep
The effect of the different depth of water on the germination of seeds.
Fimbristylis
87 days old.
J.R.

Fig. 2d.—Young weeds, *Fimbristylis annua* (All) R. & S., formerly *F. Diphylla* (Ritz) Vahl., grown in clay-loam soil in pots containing water in different amounts. The plants were grown from September 10, 1929 to December 4, 1929.

The data in table 3 further show that the characteristic appearance of the plants when grown in the field or in moist soil was materially changed when the plants were grown in soil submerged in water. The plants grew rather slowly and appeared quite fleshy, and their fruiting was very much delayed, (see figures 2c, 2d, and 2e). Also, in table 3 there may be seen records on the life cycle of the weed plants. From the rather scanty data on this point, it seems possible to state that the complete life cycle of each of *Cyperus iria, C. difformis, Panicum crusgalli,* and *Fimbristylis annua,* lasted about 90 days, when the plants were supplied with optimum amounts of moisture in the soil in pot, *Cyperus pilosus* required 126 and 106 days, and *Eclipta alba,* 134 days to complete their life cycles, that is, from the germination of the seeds to the production of seeds.

Resistance of the young weed plants to submergence in water

The six species of weeds employed in the present study appear to vary in their resistance to submergence in water. As shown in table 5, *Panicum crusgalli* was dead after 36 days submergence, while the other species were still living. In the case of *Panicum crusgallt,* the leaves first curled inwards; yellowing soon followed, finally death took place. The other weeds, *Cyperus iria, C. pilosus, C. difformis,* and *Fimbristylis annua* also showed yellowing but not pronounced until the plants had been in the water for 60 days or longer. Then, death of the plants soon followed.

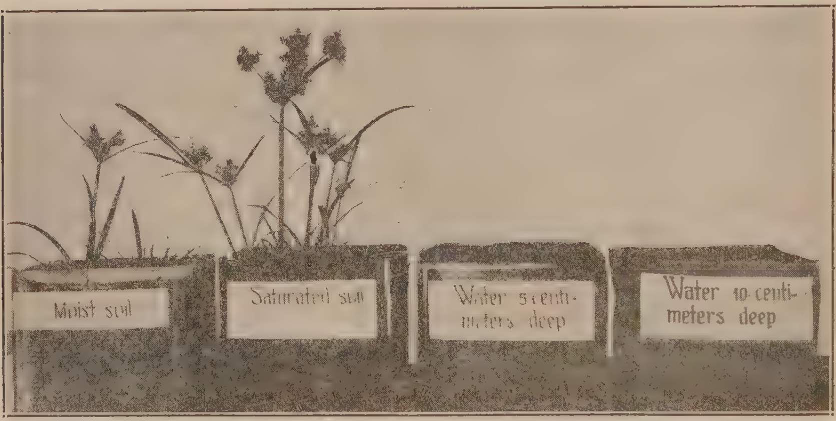


Fig. 2e.—Young weeds, *Cyperus pilosus* Vahl., grown in clay-loam soil in pots containing water in different amounts. The weeds were grown at the same time with the other weeds here studied.

The data in table 5, reveal the fact that young plants of *Eclipta alba, Cyperus iria, C. difformis* and *C. pilosus* were quite resistant when submerged in water 10 cm. in depth. Submerged in water for 24 days, *Eclipta alba* still remained alive; a continuous submergence in water for 35 days did not kill any of the Cyperaceous plants studied. On the other hand, some of the plants of *Panicum crusgalli* died after submergence in water for 35 days. The percentage of resistance, that is, the percentage of the plants that remained alive was 35 in one instance and 15 in another. As the experiments on submergence in water were prolonged, it was found that all the *Eclipta alba* plants died after about 2 months. Some of the plants of

Panicum crusgalli, *Cyperus iria* and *C. pilosus*, also died after 2 months in the water. However, a few individuals of these species were still found alive. *Cyperus difformis* was the most resistant. For, out of 40 plants that were submerged in the water, 100 per cent remained alive at the end of the 61 days in water.

Cyperus difformis was also found the most resistant to submergence in water in trial II. Continuously submerged in water 15 cm. in depth, 82.11 per cent of the plants were found alive after 91 days. *Cyperus pilosus* and *Fimbristylis annua* were also quite resistant to submergence. These plants, when submerged in water for about 3 months were not all killed; 4.41 per cent of *Cyperus pilosus* and 13.42 per cent of *Fimbristylis annua* remained alive. At the end of continuous submergence in water 15 cm. in depth for 100 days, none of the plants of *Eclipta alba* and of *Cyperus iria* remained alive. All the plants of *Panicum crusgalli* were dead at the end of 36 days.

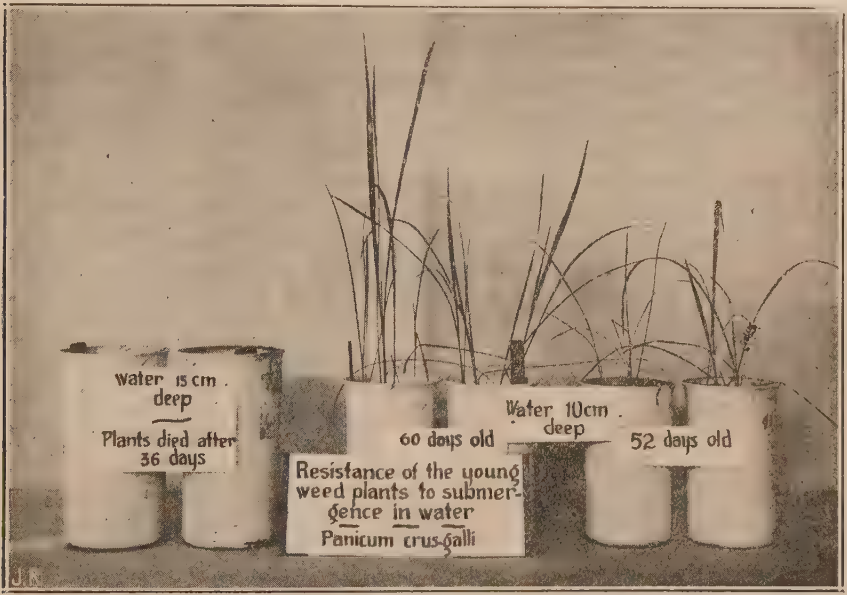

water 15 cm deep
Plants died after 36 days
60 days old
Water 10cm deep
52 days old
Resistance of the young weed plants to submergence in water
Panicum crus-galli

Fig. 3.—Young weeds, *Panicum crusgalli* Linn., grown in clay-loam soil in pots, then submerged in water 15 cm. and 10 cm. in depth. The young weed plants submerged in water 15 cm. in depth died after 36 days in water.

SUMMARY AND CONCLUSIONS

1. Seeds of the weed plants here studied failed to germinate, when sown in sand containing moisture as low as, or lower than, 30 per cent saturation.

2. Some weed seeds began to germinate within one week after sowing. Other seeds of the same plants germinated a little later. Some seeds as of *Cyperus difformis* germinated even at the end of the fourth week.

3. Germination of seeds of *Panicum crusgalli* was most rapid in pots containing 90 per cent saturation. However, the 100 per cent saturation and the supersaturated condition of the soil were quite equally favorable to the germination of the seeds of this weed.

4. The highest records on germination of seeds of *Cyperus iria*, *C. difformis*, *C. pilosus*, *Fimbristylis annua* and *Eclipta alba* were obtained in pots containing submerged soils.

5. Soil saturated with water gave the best growth and development of the weed plants and, with the exception of *Cyperus pilosus* and *Eclipta alba*, the weed plants here studied were able to show resistance to much water in the soil. At the depths of 5 or 10 cm. of water in pots, *Cyperus pilosus* and *Eclipta alba* died.

6. All the weed plants studied were quite resistant to submergence in water. *Panicum crusgalli*, however, died after having been submerged in water 15 cm. deep for only about 36 days. The other weeds remained alive in the water for 68 or more days.

TABLE 2

Showing as relative values[a] *average percentage of germination of seeds of weeds as influenced by moisture contents in pots (Data compiled from table 1)*

PERCENTAGE OF WATER SATURATION	WEED SEEDS EMPLOYED											
	Fimbristylis annua		*Panicum crusgalli*		*Cyperus pilosus*		*Cyperus iria*		*Eclipta alba*		*Cyperus difformis*	
	Trial I	Trial II	Trial I	Trial II	Trial I	Trial II	Trial I	Trial II	Trial I	Trial II	Trial I	Trial II
10	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	7	6	0	0	0	0	0	6	0	0
40	4	0	13	16	16	7	28	11	10	3	11	3
50	52	9	45	57	63	28	96	55	40	3	21	40
60	78	46	62	63	93	39	99	77	38	35	36	54
70	69	49	79	64	87	79	94	89	41	39	21	49
80	97	42	74	85	70	40	87	82	42	42	43	76
90	96	58	100	100	74	100	90	91	32	61	62	72
			(53.0)	(83.5)		(76.0)						
100	95	100	85	95	89	29	82	89	40	90	56	95
Super-saturated	100	100	92	96	100	24	100	100	100	100	100	100
	(100)	(58.0)			(83.0)		(51.0)	(74.0)	(66.5)	(62.0)	(90.5)	(73.5)

[a] The highest results on germination under each trial was arbitrarily considered as 100; the other results on germination under the same trial were converted into relative values proportionately.

TABLE 3

Effects of amounts of water in pots on growth and development of weeds

TREATMENTS GIVEN	DUPLICATE CULTURE[a]	NUMBER OF DAYS TO COMPLETE LIFE CYCLE	HEIGHT OF PLANTS	PLANTS ATTAINING MATURITY		REMARKS
				Per cent	Average per cent	
Cyperus iria Linn.						
Moist soil	a b		*cm.* 24.5[b] 28.5[b]	4 4	4.0	Plants stunted in growth; yellow; no flowers
Soil saturated in water	a b	86	42.7 48.9	54 50	52.0	Plants pale yellow; flowering began 54 days after sowing the seeds
Water 5 cm. deep	a b		54.0[b] 56.5[b]	4 2	3.0	Plants green, vigorous; no flower
Water 10 cm. deep	a b		45.0[b] 48.2	10 4	7.0	Same
Panicum crusgalli Linn.						
Moist soil	a b	87	81.5 81.3	12 22	17.0	Plants pale yellow; flowering began 74 days after sowing the seeds
Soil saturated in water	a b	87	84.4 96.5	29 40	34.5	Plants fairly developed; flowering began 59 days after sowing the seeds
Water 5 cm. deep	a b	87	80.0 93.3	8 9	8.5	Plants green, vigorous; flowering began 74 days after sowing the seeds
Water 10 cm. deep	a b		57.5 0.0	1 0	0.5	Plants green, vigorous, flowering began 87 days after planting
Cyperus difformis Linn.						
Moist soil	a b		0 0	0 0	0	No growth
Soil saturated in water	a b	87	50.5 48.4	21 37	29.0	Plants normally developed; flowering began 67 days after sowing the seeds
Water 5 cm. deep	a b	87	49.9 57.8	7 25	16.0	Plants vigorous, deep green; flowering began 67 days after sowing the seeds
Water 10 cm. deep	a b	90	54.3 58.4	18 24	21.0	Plants vigorous, deep green; flowering began 70 days after sowing the seeds
Fimbristylis annua (All) R. & S.						
Moist soil	a b		0 0	0 0	0	No growth
Soil saturated in water	a b	87	51.0 54.8	25 17	21.0	Plants normally developed; flowering began 54 days after sowing the seeds
Water 5 cm. deep	a b	87	42.7 33.0	7 6	6.5	Plants vigorous, deep green; flowering began 54 days after sowing the seeds
Water 10 cm. deep	a b		27.4[b] 18.3[b]	5 6	5.5	Plants green; rather small; no flower
Cyperus pilosus Vahl.						
Moist soil	a b	126	19.5 10.5	7 7	7.0	Plants rather stunted in growth; yellow; flowering began 90 days after sowing the seeds
Soil saturated in water	a b	106	32.5 0	14 0	7.0	Plants fairly developed; flowering began 87 days after sowing the seeds
Water 5 cm. deep	a b		0 0	0 0	.0	No growth
Water 10 cm. deep	a b		0 0	0 0	.0	Same
Eclipta alba Linn.						
Moist soil	a b		38.5[b] 21.8[b]	5 11	8.0	Plants rather stunted in growth; no flowers
Soil saturated in water	a b	134	41.3 32.2	19 20	19.5	Plants fairly developed; flowering began 104 days after sowing the seeds
Water 5 cm. deep	a b		0 0	0 0	.0	Seeds floated and germinated on surface of water; plants died after few weeks
Water 10 cm. deep	a b		0 0	0 0	.0	Same

[a] 100 seeds were sown in each culture.

[b] The height of the plant was measured from the surface of the soil to the tip of the longest leaf. Height of the other plants was measured from the surface of the soil to tip of inflorescence.

TABLE 4

Showing average per cent of plants that attained maturity (Data taken from table 3)

TREATMENT GIVEN	*Cyperus iria*	*Panicum crusgalli*	*Cyperus difformis*	*Fimbristylis annua*	*Cyperus pilosus*	*Eclipta alba*
Moist soil...........	4.0	17.0	0	0	7.0	8.0
Soil saturated in water	52.0	34.5	29.0	21.0	7.0	19.5
Water 5 cm. deep.....	3.0	8.5	16.0	6.5	0	0
Water 10 cm. deep....	7.0	0.5	21.0	5.5	0	0

TABLE 5

Data on comparative resistance of young weed plants to submergence in water

NAME OF WEEDS	DUPLICATE CULTURE	NUMBER OF PLANTS SUBMERGED	NUMBER OF DAYS THE SEEDLINGS IN WATER	NUMBER OF LIVING PLANTS	PERCENTAGE OF RESISTANCE	AVERAGE FOR DUPLICATE CULTURES	NUMBER OF DAYS THE SEEDLINGS IN WATER	NUMBER OF LIVING PLANTS	PER CENT OF RESISTANCE	AVERAGE FOR DUPLICATE CULTURES
Eclipta	a	65	24	65	100		59	0	0	
alba	b	67	24	67	100	100	59	0	0	0
Panicum	a	20	35	7	35		61	4	20	
crusgalli	b	20	35	3	15	25	61	2	10	15
Cyperus	a	20	35	20	100		61	2	10	
iria	b	20	35	20	100	100	61	3	15	12.5
Cyperus	a	20	35	20	100		61	20	100	
difformis	b	20	35	20	100	100	61	20	100	100
Cyperus	a	40	36	20	100		61	15	37.5	
pilosus	b	20	36	20	100	100	51	7	35	36.25
Fimbristylis	a	20					30	13	65	
annua	b	20					50	10	50	57.5
Eclipta	a	49	68	20	40.8		104	0	0	
alba	b	30	68	15	50	45.4	104	0	0	0
Panicum	a	29	36	0	0		36	0	0	
crusgalli	b	13	36	0	0	0	36	0	0	0
Cyperus	a	15	63	11	73.26		100	0	0	
iria	b	9	63	8	88.88	81.07	100	0	0	0
Cyperus	a	59	54	48	81.12		91	46	78.74	
difformis	b	32	54	30	93.75	87.43	91	27	85.59	82.11
Cyperus	a	36	63	5	13.85		100	0	0	
pilosus	b	34	63	7	20.58	17.21	100	3	8.82	4.41
Fimbristylis	a	23	54	10	43.50		91	2	8.68	
annua	b	22	54	12	63.63	53.56	91	4	18.16	13.42

OBITUARY

VICTOR SULIT

Victor Sulit was born in Santa Cruz, Laguna, July 28, 1896. He attended the primary and intermediate schools of his native town. In June 9, 1913 he enrolled in the six-year course of the College of Agriculture. In this college he obtained the following degrees:

B. Agr.	1919
B. S. A.	1922
M. S. A.	1923

In April 15, 1915, while still an undergraduate he was appointed student assistant in Botany, a position which he held until graduation in 1919. Shortly after graduation Sulit was appointed Assistant in Agricultural Chemistry. In 1925 he was promoted to an instructorship, and in 1927 was appointed a Fellow of the University of the Philippines.

Sulit became an orphan at an early age. He had no near relative except a half-brother. He married Miss Catalina Napisa. His widow with their children are living in Sta. Cruz.

Except for his first year in college, Sulit was entirely self-supporting. He gave signs of possible great usefulness in chemistry, the special line which he had chosen as his life work. He was very unassuming in manner, an industrious, conscientious and thorough worker.

Sulit was completing his work for the Ph. D. degree in chemistry in the University of Chicago when he contracted the disease which caused his untimely death on May 13, 1931.

F. O. S.

RESOLUTION OF CONDOLENCE

Adopted by the Faculty of the College of Agriculture, University of the Philippines, June 8, 1931

Whereas, death has come to Victor Sulit while he was in the United States as a Fellow of the University of the Philipines; and

Whereas, by his untimely death, the College of Agriculture has lost an instructor who had rendered efficient service and who gave promise of great usefulness in his chosen line, and the Philippines, a hard working man; therefore be it

Resolved, that the Faculty of the College of Agriculture, University of the Philippines, express, as it does hereby express, its deepest regret for the passing of one of its valuable members;

That this faculty extend to the members of his family its sympathy and joins with them in mourning; and further

That a copy of this resolution be sent to the bereaved family; another copy engrossed in the Philippine Agriculturist, and a third copy spread in the minutes of the Faculty of this College.

EXCHANGE NOTES

Botanizing through the forests of about a quarter of a billion years ago and comparing their floras as one would compare plants gathered only yesterday, Professor Dr. W. Gothan, curator of the Prussian Geological Institute, Berlin, has found notable similarities between the plants of England, of Schleswig in Germany, and of parts of Asia Minor. Plants of the same periods from remoter parts of the world, he found, were different from each other, just as plants from the far ends of the earth to-day are dissimilar. The differences are frequently so great that it is difficult to judge whether they were alive at approximately the same time. Nevertheless, one of his German colleagues has been able to find instructive parallels between fossil plants from Shansi province in China and others discovered by Dr. David White, of the U. S. Geological Survey, in the Canyon of Arizona.

—*Science.*

The Agricultural High School and College, in conjunction with the Council of Agriculture, will hold the Eighth Queensland Tractor School from the 31st March to 10th April, inclusive. The course will cover lectures, demonstrations and practical work in the care, adjustment, repairs and driving of many makes of tractors.

The cost to each farmer will be £3/9/6, which will cover all instruction costs, board and residence and recreation fee. The Railway Department will grant attending farmers one-half excursion rates each way on presentation of a certificate from the College. The College will provide power kerosene, the railage on tractors from and to Brisbane, and free board and residence for tractor mechanics.

Farmers will need to bring blankets, sheets, mosquito net, pillow slips, towels, soap, mirror and other toilet requisites. No farmer will be allowed to confine his attention to a particular tractor, but must work each in turn. Should he desire more work on a particular tractor, he will have to arrange it in his spare time.

—*The Australian Sugar Journal,* Feb. 5, 1931.

The United States imported more than 65,000,000 bunches of bananas last year.

—*Prairie Farmer.*

A new invention known as "R-H Fertilizer Applicator" is said to be a useful instrument to sugar planters. This invention, it is said, applies the fertilizer in an economical way and with satisfactory results. The inventors of this device are Dr. Manuel L. Roxas of the Bureau of Plant Industry and Dr. Hilario Henares, sugar chemist in the Isabela Sugar Central.

—*Commerce and Industry Journal* (Philippine Islands.)

The high-school students of agriculture in the different parts of the state are invited to the judging contest which will be held at the University Farm at Davis on picnic day, April 19. There will be competition in judging all kinds of livestock. Approximately 600 high-school students are already entered.

—*California Cultivator.*

Bolshevik bacteria, forsaking their normally useful lives of labor and rioting and robbing because they are hungry, have been discovered by scientists at the Rothamstead Experimental Station near London. They are the ordinary nodule bacteria of clover, which capture nitrogen from the air and make it available for the food of higher plants. Ordinarily they are not harmful parasites, demanding only a little carbohydrate food from their hosts in exchange for their work. But if this fails they begin to feed on the living protoplasm of the clover cells, and then attack the cell walls themselves.

It has been found that this bolshevistic behavior of bacteria follows boron starvation in the host plant. The higher plants require the element boron in extremely minute amounts, to be reckoned in millionths of an ounce. If this tiny helping of boron is missing their system of transportation tubes breaks down and the tissues no longer receive their normal supplies of food. The bacteria, finding themselves on short rations, then proceed to stage their bread riots.

—*Science News Letter* (November 8, 1930.)

Tree lovers often have to face the question of deciding whether or not a particular tree is worth the expense of treatment. Tree specialists of the United States Department of Agriculture say that most shade and ornamental trees with only a few diseased limbs are unquestionably worth attention. Others that have many dead limbs or decayed areas may not be worth the expense involved, particularly if they are rapid-growing short-lived trees. In many cases the owner will be better satisfied in the end to replace a badly diseased or mutilated tree with a healthy perfect one.

—*The Rice Journal.*

Hungary possesses one of the most fertile and productive plains in the whole world. Salt is the sole necessity that has to be imported.

—*Tropical Life*, April 1931.

COLLEGE AND ALUMNI NOTES

President Palma addressed the students on June 14. In his talk he emphasized the value to the country of the training the students in the Los Baños Colleges received. President Palma also pointed out the advantages to the students of an agricultural education.

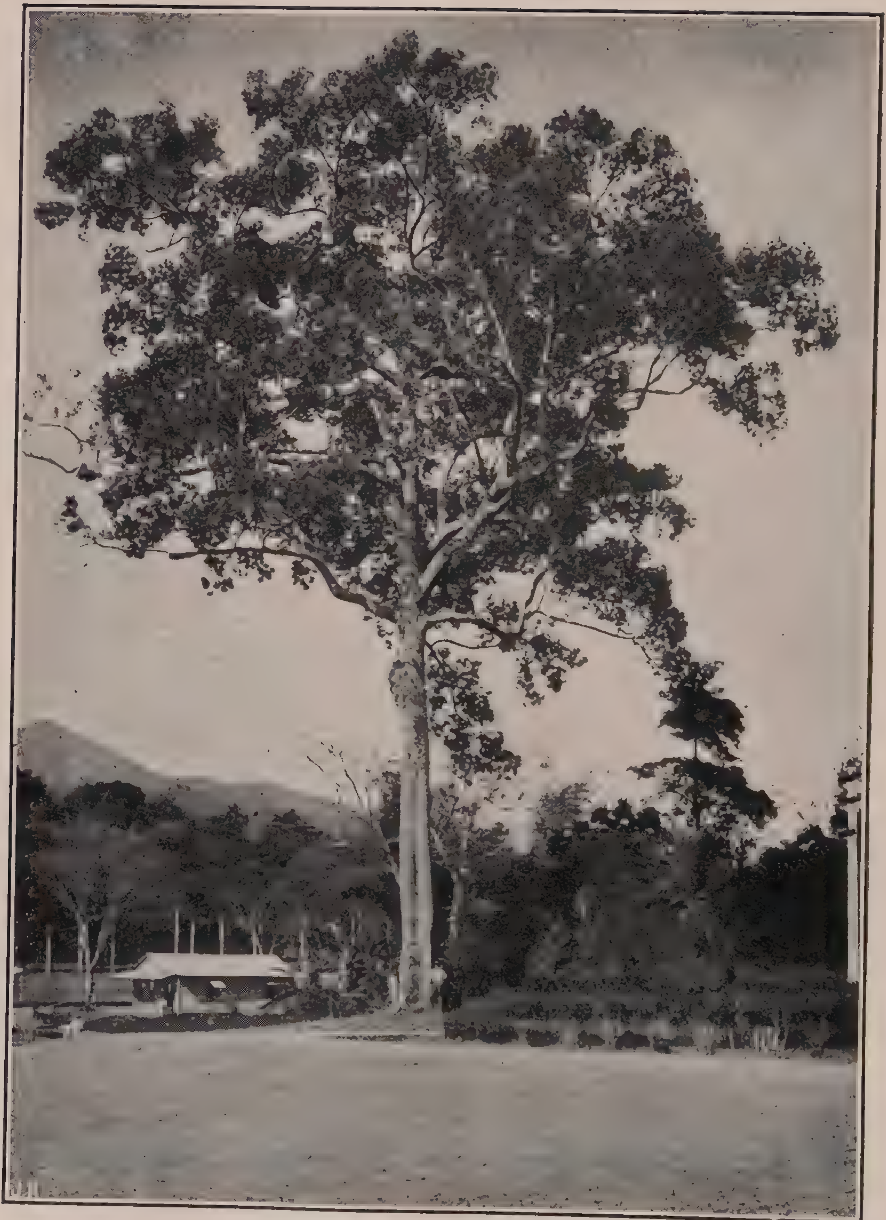
Dr. Valente Villegas, of the College of Agriculture, was elected President of the Los Baños Biological Club for the College year 1931-1932. Professor Carlos Sulit of the School of Forestry was elected Secretary.

Dr. Uichanco's article "Water-and-oil treatment against soil-inhabiting termites and ants" published in the February number (1931) of THE PHILIPPINE AGRICULTURIST was reprinted in the April number of *The Tropical Agriculturist*, (Ceylon).

Miss Fraser of the Department of English has been appointed Director of the College Sing for this College year.

Among the old B. Agr. graduates who have returned for B.S.A. and for Teacher Certificate are Magno T. Tenebro '23, Alfredo D. Pablo '25, and Agapito Muyargas '27.

The opening convocation on June 8 was the kind of students' meeting that warms the heart of the returning students and makes the new students feel at home. Doctor Manresa, Chairman of Committee on Social Affairs, presided and in his opening remarks struck the right key for the gathering. The College songs were sung with spirit. Miss Fraser was director with Honorio Ylizarde in active service in this capacity. Miss Reed was at the piano. The College yells led by José Utzurrum went with the proper bang. Dean Gonzalez' remarks conveyed a warm welcome to the new students. Tabeje welcomed the new students in behalf of the Student Body. He pictured the life of the Aggies as an existence most desirable and far from being monotonous.



THE BIG BAGTICAN
Height, June 4, 1931, 96 feet, 6 inches.

Photograph taken March 17, 1926.

THE PASSING OF THE BIG BAGTICAN[1]

The once majestic, silent, imposing Big Bagtican Tree, *Parashorea malaanonan* (Blanco) Merr., which stood on the east bank of the Molawin Creek near Campus Bridge as a towering sentinel guarding our College is now no more. For scores of years its leafy crown far above the neighboring trees had been as a dome in a foliage city. Now the mighty length of the tree lies stretched in the bed of Molawin Creek, only the memory of its omnipotence, its grandeur is left us. On June 4 two men in less than an hour destroyed what nature was more than three centuries making.

So important and prominent a landmark should not pass from our lives, especially of "old timers", without an expression of reverence for its stately life, its dignity. To those who had passed under its towering branches, stood by its sturdy trunk pointed straight to the heavens, it imparted a feeling of power, and pride untarnished by arrogance. It was an inspiration to achieve, to keep ones moral fibers straight-grained. The Big Bagtican's untimely death has left the spot where it had spent its years, yea, centuries, a place of desolation, barrenness and loneliness. Our only comfort is that a Baby Bagtican was able to spring from the Big Bagtican on the other side of the road near the Soils Building. That tree has all the promise of growing into a tree like unto its parent plant.

What changes the Big Bagtican had seen! In plant life. In human life. The last of its race at this altitude it had seen its kin disappear. Generation after generation of men lived their lives within its ken. With each generation there were changes. Finally, some twenty years ago began the thrilling experience of the Big Bagtican's life. The College of Agriculture was established in this chosen spot. The Grand Old Bagtican was a silent witness of College life in the pioneer days when professors buckled on a bolo and led in the clearing of land for campus and farm. It had seen the gradual but sure growth, expansion and development of our institution from a handful of faculty and students to what we are now—a useful institution built on a solid foundation. The Big Tree had seen buildings built and roads constructed and fields opened to accommodate the work of our growing family of faculty and students.

Progress often demands the sacrifice of things dear to the heart. Our narrow wooden bridge had to give way to a new and much larger one. The Big Bagtican stood too near. Our expansion ultimately robbed it of its soil and ground space to which it had the right by centuries of possession.

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[1] General contribution from the College of Agriculture No. 295

Some of its main ramifying root system which had maintained its life for generations were sacrificed. Destructive organisms which took advantage of this new weakness brought on by maimed strength now had the opportunity to work their way into the main body of the tree unhampered and unhindered. The Noble Big Bagtican succumbed! For two or more years it vainly tried to put on new green garments but only a few days did they persist; then withered and perished. Recovery was beyond any human control. Death was claiming the Big Tree! The axe which has brought down many a tree, either to be utilized for the happiness and comfort of mankind, or only to be allowed to rot into oblivion, did its final task—the Big Bagtican fell! Its noble length lay in Molawin Creek, whose waters had so long brought drink to its thirsty roots.

The passing of the Big Bagtican is a manifestation of the truth that "the old order changeth giving place to new", but we feel we should cry the plea, "Spare the Trees on our Campus". Let us make all effort to preserve them. Plant life has nothing more inspiring, nothing that better gratifies our sense of the beautiful, than trees. They should be left untouched, unmolested even to the point of sacrificing some material needs. We can leave no better legacy to our successors than fine trees—not alas, the Big Bagtican—which will serve as silent proof of our love and reverence for Nature's masterpieces.

José B. Juliano
Department of Plant Physiology

TREES

I think that I shall never see
A poem lovely as a tree.

A tree whose hungry mouth is prest
Against the earth's sweet flowing breast;

A tree that may in summer wear
A nest of robins in her hair.

Upon whose bosom snow has lain;
Who intimately lives with rain.

Poems are made by fools like me,
But only God can make a tree.

—Joyce Kilmer.

HISTORICAL NOTES ON THE CULTIVATION OF WHEAT IN THE PHILIPPINES[1]

REV. MIGUEL SELGA, S.J.
Director, Weather Bureau

A copy of a document in Manila, apparently hitherto unpublished, shows that in 1664 wheat was planted for the first time in the Philippines and harvested in sufficient quantities to meet local demands among the civilian population and in the army. Up to that time the supply of wheat and flour had been imported from China and Japan. Before presenting the document, in translation, some preliminary introductory remarks are here given for purposes of orientation.

1576. The majority of the old chronicles on the Philippines pointed out that what was commonly called bread was prepared from rice flour and that true wheat was imported either from the coast of Coromandel (Madras, India) or from China and Japan. Governor Francisco de Sande of the Philippines wrote from Manila to Philip II on June 7, 1576, that "the most fertile province for bread in the entire island of Luzon is that called Pampanga.....It supplies this city and the whole province with sufficient rice, which is here the bread of the whole province, so that if this should fail, it could not be obtained elsewhere." (Retana, 1896). Hence, whenever bread is mentioned in old texts, it should not be assumed that wheat bread is meant. Care should be taken to ascertain the possibility of rice bread being the commodity.

1619. In a report submitted to the King of Spain in 1619, Captain Sebastian de Pineda, a resident of Manila, mentioned the abundance, quality, and usefulness of Philippine woods in the construction of galleons and enumerated the articles which were then imported from Mexico but of which better kinds at lower prices could be obtained in Manila. He said in part: "Likewise, flour in barrels is brought from New Spain [Mexico] into the Philippine Islands which, it is said, is for the purpose of making Hosts, and this is not necessary, because in said Islands there is flour in abundance which is brought in from Japan and China. This is so cheap that in the city of Manila one quintal of it costs sixteen reales, while that from New Spain costs Your Majesty eighty reales a quintal delivered in Manila." (Colin and Pastells, 1904b). It may be deduced from this quotation that the flour consumed in Manila in the beginning of the seven-

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[1] Translated by Leopoldo B. Uichanco from the Spanish original. Translation verified by the author.

Received for publication, July 22, 1931.

teenth century was not from locally grown wheat but imported from China, Japan, and Mexico.

1626-1660. Father Francisco Colin, who lived in the Philippines from 1626 to 1660, wrote in his *Labor Evangélica*: "Wheat comes from China and flour from India and Japan, when the commerce is normal; consequently, usually bread is not wanting." (Colin and Pastells, 1904a).

1649. An account entitled *Entrada de la Seráfica Religión de Ntro. P. S. Francisco en las Islas Filipinas* was written in 1649. Retana, in 1895, published this account from the copy which was deposited in the section of manuscripts in the National Library of Madrid. This treatise repeats that the wheat used in the Philippines came from China and, before that, a great deal came from Japan. Although it admits that wheat was then raised in the Philippines, it adds that the plants continued to degenerate every year and in the fourth year seeds had to be brought in from Ternate. (Retana, 1895).

New documentary sources. The present paper deals with two additional, and little known, sources of information. (1) Legal deposition of Don Luis de Pineda to establish the proof that he was the first one to popularize the planting and harvesting of wheat in the Philippines. (2) Affidavits of competent witnesses, which confirmed the claims of Pineda.

On April 21, 1678, Sergeant Major D. Luis de Pineda Matienzo Cordero de Nevares, *alcalde ordinario* of Manila, submitted his statement in due form, as follows:

> Sergeant Major Don Luis de Matienzo, *alcalde ordinario* of this City of Manila,
>
> I declare that for the purpose of bringing before Your Majesty and the Members of the Royal Council of the Indies, through my representatives (*podatorios*), for my record, together with the rest of the papers relative to my merits and service, I claim as one of my most unique acts in this republic the popularizing of the planting and harvesting of wheat, which resulted in great usefulness and advantage to the Royal Service as well as for the common good of the inhabitants of this republic. What is more, fear is no longer felt, as has happened often before, that flour would be lacking for making Hosts for celebrating the Holy Mass. Wheat, formerly, would become so dear that a picul, which is five *arrobas*, climbed up to thirty, forty, and fifty pesos, and even one hundred pesos of eight *reales*. Frequently, there being none in stock, the arrival of sampans from the kingdom of China, from whence it comes, is awaited with singular anxiety, with the result that if they do not come in time, there is not even wheat to make biscuits with for the sailors of the vessels which sail from these Islands to the port of Acapulco, in order to fetch the coins for current expenses of the Government. The provisions of the seamen of said route were reduced at times to a few morsels of bread which in these Islands are called *potos*[2] of rice flour, which are gone in a very few months thus forcing the galleon to return, to the great affliction of the whole republic, as happened during the term of Señor Don Sabiniano Manrique de Lara. Subsequently, Señor Diego Salcedo, being then governor and captain general of these Islands, entrusted me with the duty of looking into this planting of wheat in the province of Bay,[3] where at that time I was *alcalde mayor* and *capitan de guerra*. I put into the execution of the request such care and attention and such results were produced that, shortly

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[2] Probably *poto seco*.

[3] Now Laguna.

> after, there was an abundance of wheat. With the example of my care and activity, the other provinces nearby were soon also carrying into practice this planting of wheat. From that time on in these Islands wheat became so plentiful that a picul might be bought for seven or eight reales, and, when the prices are high, two pesos. During my time, wheat was deposited in the royal warehouses so that in this country it was no longer necessary to await vessels from abroad in order to have wheat. In order that a full itemized record may be had in the aforementioned Royal Council of the Indies, I ask and implore Your Highness that you please order that this be made a part of my record.

This request ends according to the form which the prevailing laws and usage of those days prescribed. In order to strengthen his assertion, Don Luis de Matienzo presented the affidavits of Francisco Antonio de Exea and Julio de Veristain, official royal justices, and of the licentiate Don Juan de Rosales, attorney and relator of the Audiencia of Manila. The facts adduced as proofs by these witnesses would be difficult to find in other documents; and they give a good insight into the commerce of that period.

The official justices certified that in "the files of the Royal Auditor's office there was no record of entry into the royal warehouses of Manila of any sizable quantity of wheat, either from the province of Laguna de Bay or from any other part of the Islands, until the year 1664, when quantities of wheat were deposited in said warehouses from the aforementioned province, continuing from then on every year. In the years previous to that date, in order to replenish these warehouses, as well as the provisions for the ships which were sent to New Spain, it was necessary to buy wheat at high prices from the vessels that came from the surrounding nearby kingdoms."

Don Juan de Rosales, attorney of the Audiencia, was the son of Captain Blas de Rosales, who for many years had discharged the duties of the office of Secretary of the Government and War of the Philippines and had been registrar of the sampans from China. In the year 1649 Don Juan went to Mexico to study law; he returned to the Philippines from Mexico in 1659. The testimony of Don Juan on the cultivation of wheat in the Philippines was as follows: (1) Inasmuch as he was a native of Manila, he was in a position to know that in these parts no wheat was harvested and that usually this city drew its supply from what the sampans brought from the kingdom of China. (2) He knew that prior to 1649 wheat was sold at times at twenty, thirty, forty, and fifty pesos a picul and even then there were occasions that to find it at such prices was considered a great blessing. (3) Religious congregations took particular care to keep and save wheat for the Hosts for the Mass. (4) He had heard his father say that formerly special care was taken that wheat would not be lacking for the provisions of the ships. (5) He had heard many lay residents and clerics say that it was very depressing when wheat was lacking even for preparing the Hosts. (6) He had heard Don Sabiniano Manrique de Lara say that, owing to lack of wheat, a galleon for New Spain once had to be provisioned with toasted *potos* but after only a few days of voyage because of lack of food it was obliged to come back to Cavite, to the general affliction of this republic. (7) By order of Governor General Don Diego Salcedo, wheat was planted in the province of Laguna in the year 1664, and the Alcalde of the Province, Don Luis de Matienzo devoted such care to it that in a short time wheat was deposited in the royal warehouses, and from then on, its planting and harvesting became so general that "up to the present year [1678] there is wheat in such abundance that a picul may be bought for ten silver *reales* and, when it is very high priced, for two pesos;" no longer was there the necessity of depending on vessels from China. (8) Not only the province of Laguna but also that of Balayan (Batangas) and other regions produce wheat sufficient for the country. (9) Although previously some wheat was produced in some places in the Philippines, it was nevertheless so scanty that to harvest enough for making twenty loaves of bread was regarded as a rare thing and never was it continuous from year to year; neither did any one succeed in popularizing the planting of wheat until the year 1664; since that time the harvests have been so plentiful as to be deposited in the royal warehouses and so sufficient as to supply all the needs of the Acapulco ships.

So much for the testimony of Attorney Don Juan de Rosales.

In no part of the document was any town of Laguna de Bay mentioned. On account of the nature of the plant, however, the climate to which it would be adapted would be that of the towns in the higher altitudes of Laguna. This supposition is corroborated by the statement of the Provincial of the Franciscans in giving permission to the clergy of Laguna to tell what they knew about the case of Don Luis de Matienzo. The Provincial stated that Don Luis ordered the planting of wheat by the inhabitants and *principales* of the upland towns of Laguna.

There were three objects for which wheat flour was principally destined: (1) For making bread for the residents of the town; (2) for making crackers for provisions of the vessels that went to Acapulco; and (3) for making Hosts for the celebration of the Holy Mass.

Two years before Don Luis presented his petition, Father Francisco de Santa Ines had written in Manila his *Crónica de la Provincia de San Gregorio Magno.* A consummate judge of the economic conditions of that period, Father Francisco affirmed that "wheat formerly came from China. ... Now, it is planted and harvested in the Islands in abundance and the supply has been so great these years that the highest price for a *fanega*[4] has been from twelve to fourteen *reales* and in the present year 1667, nobody will buy it at ten. It is fortunately very cheap, even more so than in Spain." (Santa Ines, 1667).

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[4] Grain measure, about 56 liters.

Documents of that period show very clearly that the cultivation of wheat, which Matienzo started in the Philippines in 1664, continued actively for seventy years to the evident advantage of the people. In 1738, in Sampaloc, Manila, Father Juan Francisco de San Antonio published his famous *Crónicas de la Apostólica Provincia de San Gregorio.* In speaking of the beauty and fertility of the Philippine Islands, Father Juan Francisco writes that "wheat was formerly brought in from China, India, and Japan (when the commerce was not interrupted); very good flour came, so that the Spaniard rarely missed bread on his table, just as there was no lack of Hosts for the celebration of the Holy Mass. But now wheat is grown in these Islands in abundance; and so much so that a purchasing *Bandála* allots shares for making biscuits for the ships that go to Spain. There are in Manila public bakeries with fine bread for anybody, and in the outside provinces it is not lacking either. Even in the mountains, where bread is not made, good biscuits may be secured by those who can afford to pay; so that it is no longer necessary [to import] from foreign countries, except in times of great scarcity, because in these Islands there are sufficient harvests." (San Antonio, 1738).

Corroborating this statement, faithfully, was that of Father Juan Delgado, who, writing in 1751 his *Historia General*, painted with a master hand the social and economic conditions of the Visayas. Of the wheat, properly speaking, Delgado states that "it has been cultivated in this region for a few years and it yields with great abundance in the island of Manila and the province of Taal and Balayan. The same thing has happened in the Ilocos, from which come sampans laden [with wheat] which ordinarily produces good biscuit, bread, cake, lady fingers, caramel, and similar other articles which are as good as those in Spain. Well may the wheat deserve the first place among the kinds of grains, that are called cereals, because of its stateliness and usefulness; although in these Islands and in all of Asia, even if the wheat should fail, there would be no famine; but there would be, and a horrible one, if there should be a lack of rice, which is our daily bread and is undoubtedly more nourishing than wheat." (Delgado, 1892).

Anticipating the breach of hostilities between Spain and England, the Government of Madrid sent to Manila in 1796 the fleet of General Don Ignacio Maria de Alava, which was composed of three warships and six frigates, in order to defend the site of Manila in case of war. The General "wishing to acquaint himself with the physical, geographical, and political conditions of these Islands," undertook in 1800 a series of trips to the provinces in the neighborhood of Manila. He requested to accompany him as a guide the Augustinian Father Joaquin Martinez de Zuñiga, whose superior knowledge of the country and keen power of observation are well and generally known. On arriving at Lipa, all the members of the party spoke in praise of the kindness of the residents and the mildness of the temperature. In connection with the cultivation of wheat, Zuñiga writes the following:

> The land of Lipa is rather rough, but thick and with much nutriment and essential constituents; it yields much rice, and produces many fruits and leafy vegetables indigenous to the country and likewise wheat, which [when] sent to Manila, bring the natives sufficient money to enjoy life in comfort.
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> Wheat needs little water for growth. It is planted toward the month of November, at the close of the wet season. The time of harvest is toward the end of February or the beginning of March. During all this time heavy dew falls which keeps the wheat fresh and promotes abundant harvest, unless some fogs set in, which are very injurious. Wheat is sold by the picul, which is a unit of weight of 137 pounds; however, it is not weighed, but measured, and it is so adjusted that thirty gantas make one picul, and, given this measure, it always weighs so, more or less. Twenty-five gantas make one fanega, and, hence, a picul of wheat measures one and one-fifth Spanish fanegas. This amount usually costs two pesos, Indian [Philippine?] currency, and at times it costs as much as seven or eight pesos. The result of this high price is that only the Spaniards eat bread in this country, and the Indian [Filipino] only plants wheat to the amount that can be consumed in Manila; because, if he should plant more, he will have a surplus in his granary and he will lose money. On the failure of harvest or increase in consumption, the price soars unusually high; during all this war time it cost from six to seven pesos a picul, and even then the Indians [Filipinos] could not make exorbitant gains owing to their accustomed indolence, and they could not be aroused to plant enough for the maintenance of the fleet. The General found himself obliged to send to China for wheat, and the laziness of our planters has made us give outsiders much silver which could have remained with them. It is true that these times, when money abounds, are bad for promoting any line of business in the Philippines, because, since the natives find with ease their daily support, and they make little provision for the future, they become lazier than ever, and work less and less as securing food becomes easier. (Martinez de Zuñiga, 1893.)

The *Guía de Forasteros en las Islas Filipinas*[5] for the year 1848 contains a list of factories set up in the Archipelago since 1828. Among the machines operated with horses there was "one for grinding wheat, located in the Barrio of Gunao, the property of Don Antonio Jimenez".

Later on, on account of increase in commercial facilities and in speed of ships, large quantities of wheat flour were imported from foreign countries where the grain was raised on a large scale, with the result that it did not pay in the Philippines to plant and cultivate wheat at great expense, inasmuch as imported wheat could always be obtained in the market at much lower prices than that produced in this country. If wheat cultivation was given up in the Philippines, it was not necessarily because of uncongenial climate, but because competition in foreign trade brought to Manila better wheat at lower prices.

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[5] Foreigners' guide in the Philippine Islands.

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A BACTERIAL STEM-ROT OF HYBRID CANE SEEDLINGS HITHERTO UNREPORTED[1]

E. F. ROLDAN[2]
Of the Department of Plant Pathology

WITH FIVE PLATES

A hitherto unreported bacterial stem-rot of hybrid seedlings of sugar cane (*Saccharum officinarum* L.) and Philippine Kassoer in the Philippine Islands attracted the attention of the writer in September, 1929. The disease was present in the seedling-cane cultures of the Plant Breeding Division, Department of Agronomy, College of Agriculture at Los Baños, Laguna.

On a trip in March, 1930 to Canlubang, Laguna and Del Carmen, Pampanga, the writer noted advanced stages of the disease on mature seedling canes in these two places. From this occurrence of the disease it is seen that the causal bacterium is not restricted to the fields of the College of Agriculture at Los Baños. So far as the writer knows this bacterial disease has never been reported elsewhere. The malady is sporadic on hybrid cane seedling varieties. Wherever the disease appears, two or more stalks of the invaded stools are usually affected. Microscopic examination of free-hand sections of tissues prepared from newly infected canes, and juice expressed from the same, showed an abundance of actively motile bacteria. Isolations of the causal organism persistently gave motile bacteria like those found in the diseased cane tissues. Thus far the following hybrid seedling-cane varieties known to be susceptible to the disease are: P. B. 308[3], P. B. 309, P. B. 345, P. B. 395 and P. B. 407, the products of crossing P. B. 119 ♀, with C. A. C. 87 ♂. Outside the hybrid seedling canes, the disease was observed only on variety Cagayan Striped.

Infection by the causal bacterium spreads throughout the entire stalk. When canes are infected with the disease they usually succumb. The malady renders the canes worthless because infection is followed at once by rapid deterioration and fermentation of the juice. If the disease spread to important commercial varieties of sugar cane the malady might develop into an important factor in sugar cane culture.

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[1] Experiment Station contribution No. 738. Read before the Los Baños Biological Club, March 22, 1930. Received for publication May 23, 1930.

[2] The writer wishes to thank Dr. G. O. Ocfemia of the Department of Plant Pathology for suggestions and criticisms on this paper. Also, Dr. N. B. Mendiola, of the Department of Agronomy for valuable suggestions, and for authorizing the use of the department's seedling-cane cultures by the writer.

[3] P. B. = Plant Breeding Division number of hybrid seedling cane varieties.

It was the writer's object in the present work to describe the disease and its causal bacterium. To aid in preventing the disease from assuming dangerous proportions, methods of control, based on the characteristics of the disease and physiology of the causal bacterium are also suggested.

THE DISEASE

Description

The first noticeable symptom of the disease is the appearance of pale yellow to yellowish brown color over the entire foliage of diseased canes (pl. I, fig. 1-4). This is followed by rolling and wilting of the leaves (pl. II, fig 1). In contrast with healthy canes, diseased canes exhibit a typical sickly condition. Infected stalks can be readily singled out from the healthy ones. Soon after infection has been well established, rapid deterioration of the inner tissues of the stalk ensues. The side buds and the region of the growing point of the shoot, which are tender and least resistant to invasion by foreign organisms, rot readily As a result of this rotting of the embryonic tissues the tops of infected stalks fall over. The rotting and falling over go on faster when the weather is humid and cool. The tops are cut off just a few centimeters below the spindle. In some rather rare cases, and when the weather is dry so that the development of the disease is somewhat retarded, the falling over of the tops does not occur. In the advanced stage of the disease infected stalks give off a peculiar, rather offensive, or at least unpleasant odor, characteristic of fermenting and putrifying organic matter. Flies and other insects are attracted and they frequent the rotting canes. According to Smith (1920) one of the signs of *Bacillus carotovorus* Jones on cruciferous roots and onions is emission of an offensive odor.

When the diseased cane is cut open, it shows no discoloration in the vascular region, such as is shown by the Australian leaf-scald disease described by North (1926) which was first reported by North and Lee (1923) and the gumming disease of sugar cane reported by Cobb (1905). The internal tissues, however, lose their natural lustre. They become pale to light greenish yellow and water-soaked and the consistency becomes soft. The natural lustre of the rind also disappears and it becomes dull, as if the stalk had been scalded with hot water. In the growing region of the shoot, where the tissues are young and tender, cracks may be seen running parallel with the fibers (pl. III, fig. 1–2). The cracking seems to result from the disorganization of the cells caused by the action of bacteria. The disease may attack young canes about 60 centimeters high, although those approaching maturity are the ones usually affected.

CAUSAL ORGANISM

Method of isolation

The bacterium causing the disease was isolated without any difficulty. Pared tissues of diseased canes taken under aseptic conditions from the internode and dropped directly into the test tubes containing sterile nutrient broth or cane juice water peptone[4] gave pure cultures. Pared tissues sterilized by dipping them into 95 per cent ethyl alcohol and flamed over the alcohol lamp and then dropped into sterile nutrient broth or cane juice peptone water in test tubes also gave pure cultures. Either method proved satisfactory for isolating the causal bacterium. From the original culture, subcultures were made either by means of agar poured on plates or by making the streak culture on agar-beef-peptone slant with a platinum loop directly from the broth cultures. Nutrient broth or cane juice peptone water proved to be good basic media for the isolation of the bacteria.

Morphology

The causal bacterium is a cylindrical rod, (pl. II, fig. 2) with more or less rounded ends. The cells occur singly or in pairs, occasionally in chains, and in clumps in nutrient-broth cultures 24 to 48 hours old. According to Smith (1920), *Bacillus carotovorus* Jones forms chains as long as 200 μ. The cane bacillus does not form chains this long. Films prepared from the juice of newly infected canes and stained with aniline gentian violet gave measurements of the cells ranging from 0.95 to 2.2 by 0.5 to 0.7 μ. The size of the sugar cane bacillus is 0.6–2.8 μ shorter and 0.1–0.2 μ narrower than *Erwinia carotovora* (Jones) Holland (Bergey *et al*, 1925). No spores have been noted. Thin capsules (pl. IV, fig. 2) are formed in three-day-old nutrient-agar slants. The cells are motile by means of peritrichic flagella numbering from four to several (pl. II, fig. 4). No marked involution forms were observed in one-month-old fluid cultures. The bacterium is Gram negative and non-acid fast.

Evidence of pathogenicity

To prove the pathogenicity of the bacillus, inoculation experiments were conducted in the field. A hypodermic syringe was employed for conveying the inoculum to the experimental plants. In every set of inoculation experiments ten stalks were inoculated and ten were used as checks. Inoculations were made only within hybrid cane seedling varieties on which the disease was observed. Seedling canes at different ages were inoculated. Young cultures in nutrient broth and in cane juice peptone water of not less than 24 hours and not more than 48 hours old, or bacterial suspension in sterile water prepared from 24-hour-old agar-slant culture were used. One cubic centimeter of the fluid culture or bacterial suspension in sterile water was injected into the plants with a sterilized hypodermic syringe. Before injection, the site of inoculation was rubbed with cotton soaked in 95 per cent ethyl alcohol. Injections were made either at the base of the plants, that is, about five to ten centimeters above the root stock, or in the spindle. All inoculations were checked by control cane stalks in which sterile nutrient broth, sterile cane juice peptone water, or sterile distilled water, as the case might be, was used. Table 1 gives the summary of the results ot the inoculation experiments.

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[4] Formula according to Miss G. Wilbrink: Cane juice 25 cc., peptone two grams, and water 75 cc.

In table 1 it may be noted that infection was successfully produced on inoculated plants. The checks invariably remained normal. The organism was recovered in reisolation. The difference in percentage of infection obtained from the two methods of inoculation may also be noted. Sixty per cent was the highest percentage of infection secured from inoculations performed at the base and thirty per cent was the lowest. Inoculation on the spindle gave as high as sixty to ninety per cent. Inoculation through the spindle, however, did not produce symptoms resembling in all respects those that are produced in natural infection. In inoculations through the spindle, infection was confined to the growing point and the disease did not spread to the entire stem. Inoculations made at the base produced infection with symptoms exactly the same as those produced in nature. It may be noted also that the disease required a longer incubation period when cane plants were inoculated at the base than when inoculation was made through the spindle. The incubation period ranged from six to ten days when inoculation was through the base and from three to seven days when through the spindle. The length of the incubation period seems to depend to a certain extent upon the age of the plants used and the environmental conditions existing at the time of inoculation. It was noted that on younger plants the incubation period was shorter, and that humid cool weather hastened infection and thus shortened the period.

Cultural characters

Agar colonies+10. Colonies were visible after 24 hours at room temperature (24°–28°C.). They were circular, convex, dirty white at first, later turning pale almost greenish in color, moist, opaque, entire and homogeneous (pl. IV, fig. 1, 2). Later the colonies became finely granular with a dense growth at the center (pl. V, fig. 1). The colonies were 0.5 to 1.0 mm. in diameter after 24 hours. In 48 hours the diameter increased to 2.0 mm. and in 72 hours to 6.0 mm. Buried colonies are spindle-shaped, or fusiform and umbunate (pl. V, fig. 2–4).

Nutrient agar+10 streak culture. The organism showed fair growth after 24 hours. The streak was filiform, raised, glistening, slimy, dirty white, butyrous to slightly slimy and opaque. No change in color of the medium was produced.

TABLE 1

Summary of the results of the field inoculation experiments with the bacteria isolated from stem-rot of hybrid cane seedlings

DATE OF INOCULATION	NUMBER OF PLANTS USED		SITE OF INOCULATION	KINDS OF INOCULUM	NUMBER OF PLANTS INFECTED		PERIOD OF INCUBATION	PERCENTAGE OF INFECTION
	Inoculated	Check			Inoculated	Check		
							days	
Nov. 11, 1929	10	10	Spindle	Bacterial suspension in sterile distilled water.	6	0	5–7	60
Nov. 11, 1929	10	10	Spindle	Culture in cane juice peptone water.	7	0	4–7	70
Dec. 12, 1929	10	10	Spindle	Nutrient broth culture.	9	0	3–6	90
Jan. 4, 1930	10	10	Base	Cane juice peptone water culture.	6	0	6–10	60
Jan. 4, 1930	10	10	Base	Nutrient broth culture.	5	0	6–9	50
Jan. 12, 1930	10	10	Base	Bacterial suspension in sterile water.	4	0	6–9	40
Feb. 14, 1930	10	10	Base	Cane juice peptone water culture.	3	0	6–10	30
Feb. 14, 1930	10	10	Spindle	Cane juice peptone water culture.	7	0	4–7	70

Nutrient broth + 10. This medium became uniformly turbid after 24 hours. A thin, dirty white slimy membrane formed on top. Slight jarring caused the detachment of the flocculent bodies and these later settled down. Clouding was progressive with continuous formation of pellicles within a few days.

Cane juice peptone water+10. This medium became uniformly turbid after 12 hours. The turbidity became more intense after 24 hours with heavy pellicle on top. The growth was progressive with a heavy accumulation of sediment and pellicles. Slight jarring broke the pellicles and these settled down.

Nutrient gelatin (one per cent acidity) stab culture. The line of streak was filiform. The growth was very moderate but most active on top. In 15 days the medium was liquified.

Leoffler's blood serum. The growth was moderate, filiform, raised-flat, dull and primrose-yellow.[5] The medium was not liquified even after three months.

Milk. Milk was curdled in three days. The whey and curd separated at the end of six days. The top and bottom cleared in four weeks. The action of the sugar cane bacterium upon nutrient gelatin, Loeffler's blood serum and milk are much like that reported by Smith (1920) for *Bacillus carotovorus* Jones.

Potato plug. The growth after 24 hours was moderate and raised, later spreading on the surface. The growth was glistening, smooth and wax-yellow. After four days the plug became light vinaceous to pallid-pale vinaceous drab. The odor decidedly resembled that of burnt egg shell.

Dunham's solution. This solution became uniformly turbid after 24 hours. Thin pellicles which broke with slight jarring formed on the surface. After three days, turbidity became more intense with persistent accumulation of pellicle on top.

Cohn's solution. Clouding was moderate after 24 hours and thin pellicles, which broke with slight jarring, were formed. The turbidity was progressive. Minute, metallic, and crystal-like particles were present and these hung on the surface of the fluid and adhered to the walls of the tubes.

Fermi's solution. This became slightly turbid after 24 hours. Growth was progressive and there was a formation of heavy pellicles.

Nitrate solution. Clouding was moderate throughout without any formation of pellicle.

Fermentation tubes. The organism was tested in media containing one per cent peptone and two per cent saccharose, dextrose, lactose, maltose, levulose, galactose, mannit, raffinose, arabinose, xylose, rhamnose, melozitose, dulcitol, glycerine, dextrin and inulin. Acid was formed with strong clouding in open arms, gas and faint clouding in the closed arms in all the media except in dulcitol, inulin, dextrin and glycerine. The absence of gas in glycerine is also a characteristic of *Bacillus carotovorus* Jones (Smith, 1920).

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[5] Color nomenclature after Ridgway, Robert 1912. Color standards and color nomenclature, 43 p., 53 colored plates, 1115 named colors. Washington, D. C.

Litmus milk lavender color. The top portion blued after three days. This color lasted for six days, after which it was gradually reduced until the entire medium was decolorized. The milk underwent curdling and clearing as did plain milk. It was rendered acid.

Congo red agar. Thin growth developed along the streaks in two days when the medium began to become purple from the bottom and by the end of five days the entire medium had gradually become this color.

Physiology

Thermal death point. The thermal death point lies between 50° and 51°C. Growth was produced at 50°C., but no growth occurred at 51°C. The thermal death point of *Bacillus carotovorus* Jones is also 51°C. (Smith, 1920).

Resistance to desiccation. The organism is sensitive to desiccation. Cover slips were sterilized by passing them over the alcohol flame several times. On each of the cover slips was placed a standard loop of 24-hour-old nutrient broth culture of the cane bacillus. The cover slips were then placed in sterile petri dishes and allowed to air-dry at room temperature, 24°–28°C. After 24 hours two cover slips were dropped in nutrient broth and another two were plated out. At the end of 24 hours no growth was observed, thus showing that allowing the organisms to dry for 24 hours killed them. The experiment was repeated, except that the bacterial films were allowed to air-dry for 12 hours only. After two days faint growth was observed. Later, the growth became progressive. The shortest time that the bacteria can be allowed to become dry without affecting their viability was not determined. Their sensitiveness to drying is similar to that of *Bacillus carotovorus* Jones. The Jones' soft rot bacterium, however, is said to die after even two minutes' exposure to dry air. As the sugar cane bacterium can remain viable for over 12 hours in an air-dry condition, it differs from *Bacillus carotovorus* Jones in this respect.

Toleration of sodium chloride in beef bouillion +10. Growth was produced within 12 hours in medium with one and two per cent sodium chloride and within 18 hours in three per cent. Feeble growth was produced after 24 hours in four per cent. In five per cent the medium became faintly turbid after three days and the growth remained feeble and not progressive. In six per cent no growth occurred. *Bacillus carotovorus* Jones can tolerate sodium chloride up to seven per cent.

Diastatic action. Colonies in beef-peptone agar containing 0.2 per cent starch were tested after 24 hours and then after seven days with saturated solution of iodine in fifty per cent alcohol. No clear zone was noted around any of the colonies, thus showing that there was no diastatic action. Other tests made with Eyre's method (1916) also gave negative results. The negative result for diastase by the iodine test shows that the bacterium of the sugar cane does not liquify starch in the same manner that *Bacillus carotovorus* Jones does (Smith, 1920).

Reduction of nitrates. No reduction of nitrates to nitrites by Smith's (1905) method was noted when one week-old cultures were tested. In this reaction the cane bacillus differs from *Bacillus carotovorus* Jones because the *carotovorus* bacterium is a nitrate-reducing organism.

Production of hydrogen sulfide. Strips of lead-acetate paper suspended over the mouth of the test tubes with young and old nutrient broth cultures did not produce black color on the paper.

Production of ammonia. Cultures in two per cent peptone water, beef peptone broth, and cane juice peptone water, showed production of ammonia. The reaction was positive when fluid cultures were treated with Nessler's solution.

Indol production. Positive results were obtained when the test for indol was made.

Aërobism. Shake-culture of beef-peptone agar showed growth only on the top and none within the substratum. This shows that the organism is aërobic like *Bacillus carotovorus* Jones (Smith, 1920).

Longevity. Isolations made from the host tissues which were kept in the laboratory for three months gave pure culture of the organism. Transfers made from cane-juice-peptone water, milk, and beef-peptone broth cultures showed that the organism remains alive for six weeks under laboratory conditions at 24°-28°C. in cane-juice-peptone water, five weeks in milk, and three weeks in beef-peptone broth.

Reaction to media. The organism showed the best growth between +5 to +15 (Fuller's scale). The cultures began to turn turbid after eight hours. Faint growth was observed in -20 and +20 after two days; there was none in -25 or +25. The optimum growth seems to be around +10. Jones' *carotovorus* bacillus has a much wider range of reaction; it grows from -40 to +30 on Fuller's scale.

CHROMOGENESIS

In nutrient broth culture, cane-juice-peptone-water cultures and colonies in nutrient agar the organism was dirty white to pale greenish. On potato plug the color was yellow. This color is probably the same as that described in a footnote on page 230 of Erwin Smith's book (1920) and is not regarded as true chromogenesis.

PATHOLOGICAL ANATOMY

Free-hand sections made from tissues of the internode of newly infected canes when examined under the microscope showed the presence of the parasitic bacteria throughout the intercellular spaces. In more advanced stages of the disease, however, when the tissues are becoming soft and the juice is fermenting, the parenchymatous cells are occasionally found densely filled with bacteria (pl. III, fig. 3). The bacteria were not observed in the vascular tissues. The absence of the bacteria from the vessels suggests that the organism is not a vascular parasite. It seems highly probable that at the beginning of infection the bacteria occupy the intercellular spaces but as infection progresses, disorganization of the cells takes place and this allows the bacteria to migrate fully. The bacteria probably secrete enzyme that acts particularly on the middle lamella in the same manner as *Bacillus carotovorus* Jones (1905). This causes the cells to become loosely held together. The dissolution of the cementing materials of the cells followed by the subsequent destruction of the cellulose walls seems to be the cause of the spread of the water from the vacuoles of the cells. This spread of the water seems to be the explanation for the water-soaked conditions of the tissues of the cane stalk. The presence of the organism within the cell lumen in advanced stages of infection is also due to the rupturing of the cell walls. The bacteria are not only present in the tissues of the stem, side buds and shoots but are found also in the roots of diseased canes. No bacteria were found in the leaves.

TAXONOMIC CONSIDERATIONS

In the present work it was not possible for the writer to compare the sugar cane bacillus with authenticated culture of *Bacillus carotovorus* Jones. An analysis of the characters of *B. carotovorus* (Smith, 1920 and Bergey *et al*, 1925) and comparison made with the sugar cane bacillus shows that the following characters are common to both:

1. *Morphology*
   a. Both are cylindrical rods with more or less rounded ends.
   b. Both are peritrichiately flagellate.
   c. Both are non-sporiferous.
2. *Physiology*
   a. Both have the thermal death point at 51°C.
   b. Both are aërobic.
   c. The color produced is nearly the same.
   d. Both ferment the same sugars with production of gas.
   e. Neither produces gas in glycerine.
   f. Both act in the same manner on nutrient gelatin, Leoffler's blood serum and milk.
   g. Both are Gram negative and non-acid fast.
3. *Host relations*
   a. Both produce the same signs on host plants.
   b. Both act upon the medulla mella of the cells and the cell walls are later dissolved by enzyme produced.

The bacillus of sugar cane differs from *Bacillus carotovorus* Jones in the following characters:

1. *Morphology*
   - a. The cane bacillus has more than five flagella.
   - b. In size the cane bacillus is slightly smaller than the *B. carotovorus* Jones.
   - c. The cane bacillus produces a thin capsule after three days in nutrient agar slant.
   - d. The cane bacillus forms chains only occasionally and they are not so long as those of *Bacillus carotovorus* Jones.
2. *Physiology*
   - a. The optimum temperature of the cane bacillus is 30-35°C.; of the *Bacillus carotovorus* Jones it is 25-30°C.
   - b. The sugar cane bacillus is non-nitrate-reducing.
   - c. *Bacillus carotovorus* Jones tolerates sodium chloride as high as seven per cent but the sugar cane bacillus tolerates no higher than five per cent.
   - d. *Bacillus carotovorus* Jones has a reaction range of medium from –40 to +30 (Fuller's scale) while the cane bacillus has a much narrower range being only –20 to +20 (Fuller's scale).
   - e. The cane bacillus can remain in an air-dry condition more than six times as long as the *Bacillus carotovorus* Jones can.
   - f. The cane bacillus does not liquefy starch while *Bacillus carotovorus* does.

In view of the morphological and physiological differences between the sugar cane bacillus and *Bacillus carotovorus* Jones, the writer is of the opinion that the two forms are not identical. Provisionally, at least, the writer suggests the binomial *Bacillus sacchari*, n. sp. for the sugar cane pathogen.

TECHNICAL DESCRIPTION

***Bacillus sacchari*, n. sp.=*Erwinia sacchari*, n. sp.**[6]

Cylindrical rods with more or less rounded ends; occurring singly or in pairs, occasionally in chains and in clumps in 24- to 48-hour-old fluid cultures; cells from 0.95 to 2.2 by 0.5 to 0.7 μ. The rods stain readily with carbol fuchsin and aniline gentian violet but faintly with methylene blue even with longer exposure to the stain. The rods are motile by means of four to several peritrichiate flagella which were demonstrated by Maneval's (1929) method. The bacillus is non-sporiferous. Thin capsules are formed in three-day-old nutrient-agar-slant culture, Gram negative, and non-acid fast. No marked involution forms are produced.

The bacillus produces moderate growth, with heavy pellicles in beef peptone fluid. Strong clouding with heavy pellicles and sediment are produced in cane-juice-peptone water turning later to light green. Cohn's solution becomes uniformly turbid after 24 hours with pellicles and minute triangular crystals formed on top and along the ring. In Fermi's solution it causes moderate clouding with heavy pellicles. Agar-beef-peptone colonies are circular, first convex but later raised, and umbunate, smooth, glistening pale green, entire, homogeneous with dense growth in the center. Buried colonies are fusiform, or spindle shaped and variously umbunate. Liquifies nutrient gelatin but not Leoffler's blood serum. Optimum temperature between 30° and 35°C.; thermal death point 51°C. Milk curdled and cleared from top to bottom after one week. Litmus milk blued on top after three to five days, later turning white and becoming acid. Hydrogen sulfide is not produced in beef-peptone fluid. Congo red agar becomes purple after two to three days. Ammonia and indol are produced; but nitrates are not reduced to nitrites. The bacillus produces acid with evolution of gas in saccharose, mannit, raffinose, lactose, maltose, levulose, xylose, rhamnose, and melozitose. It produces acid without gas in glycerine, dextrin, dulcitol and inulin. It does not hydrolize starch and is aërobic. It tolerates sodium chloride as high as five per cent. Growth on medium with reactions between -20 to +20 on Fuller's scale; but the best growth is produced at about +10 Fuller's scale. It remains alive longest in peptone cane juice water culture. In 24- and 48-hour-old fluid cultures the organism is killed when desiccated for 24 hours. Pathogenic on hybrid cane seedlings and Cagayan Striped. According to the Chart of the Committee of the Society of American Bacteriologists, the group number is 5011-31124-0111.

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[6] Nomenclature after the Committee of the Society of American Bacteriologists, 1920.

Habitat. On hybrid seedling varieties, and Cagayan Striped canes (*Saccharum officinarum* L.) at the College of Agriculture at Los Baños, Laguna, and at Canlubang, Laguna and Del Carmen, Pampanga.

The type specimen is deposited in the Pathological Collections of the Department of Plant Pathology of the College of Agriculture.

CONTROL MEASURES

In its present form this bacterial stem rot of sugar cane may be readily controlled by digging out and burning the entire stools as soon as diseased stalks are noted among them. No cuttings for planting purposes should be taken from stools in which there are diseased stalks. Because of the sensitiveness to drying of the bacillus, the stalks of the stools in a case of severe infection should be cut and burned with the stubble. The soil should be plowed up and exposed to direct sunshine to dry and thus kill the bacteria in the cane debris in the soil.

SUMMARY

Hybrid seedlings and Cagayan Striped canes showing bacterial rots in the stems were noted and collected from the sugar cane cultures of the College of Agriculture at Los Baños, Laguna. The disease was subsequently found on hybrid cane seedlings in Calamba, Laguna, and in Del Carmen, Pampanga.

So far as the writer knows, the bacterial stem rot of cane seedlings has not been reported before either from the Philippines or elsewhere. Although it is of a sporadic nature at the present time it is feared that it may spread to commercial varieties and become a serious trouble in sugar culture.

The disease is shown by the yellowing or browning of the leaves followed by rolling and wilting. The side buds and the main shoot rot. The rotting of the main shoot often causes the falling over of the tops, especially when the weather is humid and cool. The inner tissues of the stalk deteriorate rapidly and in advanced cases a peculiar rather unpleasant smell characteristic of rotting organic matter and fermentation of sugary substance is given off. Very often flies and other insects are attracted by the foul odor of infected stalks. The natural luster of the rind and the inner tissues is replaced by a dull water-soaked appearance.

Isolation from tissues of infected canes gave pure cultures of a pale almost greenish bacterium. When introduced by means of hypodermic syringe the organism in pure culture readily reproduced the disease on healthy hybrid cane seedlings. When infection is severe, the disease may kill all the stalks composing the stool.

The disease and the morphology and physiology of the causal organism were studied. There are points of resemblance of the causal bacillus with *Bacillus carotovorus* Jones but the morphological and physiological differences show that the two forms are not identical. The name *Bacillus sacchari*, n. sp. is suggested for the causal organism.

As a means of prevention sanitary measures are recommended.

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ILLUSTRATIONS

Plate I

Fig. 1. Portion of the stem of an artificially inoculated seedling cane variety P. B. 308 showing the natural appearance of a young stage of infection of the bacterial stem rot. ×3/4.

Fig. 2. Portion of the shoots of an artificially inoculated seedling cane variety P. B. 308 showing the natural appearance of a young stage of infection of the bacterial stem rot. ×3/4.

Fig. 3. Portion of the shoot of seedling cane variety P. B. 308 showing the appearance of the plant with the advanced stage of natural field infection of the bacterial stem rot. ×3/4.

Fig. 4. Portion of the stem of seedling cane variety P. B. 308 showing the natural appearance of the advanced stage of natural field infection. ×3/4.

Plate II

Fig. 1. Top of seedling cane variety P. B. 345 showing the wilting condition resulting from natural field infection. ×1/16.

Fig. 2. Top of seedling cane variety P. B. 345 showing early symptom of infection resulting from artificial inoculation through the spindle. ×1/16.

Plate III

Fig. 1. Top portion of the spindle, cut open to show the cracks and depressions at the growing region of seedling cane variety P. B. 308. Natural infection. ×1/2.

Fig. 2. Portion of the spindle of Cagayan Striped cane showing cracks resulting from natural field infection. ×7/8.

Fig. 3. Portion of the foliage showing early symptoms of wilting resulting from artificial inoculation at the base. ×1/2.

Plate IV

Fig. 1. Colonies on three-day-old agar-poured-plate culture. ×5/6.

Fig. 2. Smear from 24-hour-old agar slant culture stained with aniline gentian violet. ×900.

Fig. 3. Smear from three-day-old agar slant culture stained with Welch's method for capsules. ×900.

Fig. 4. Smear from 24-hour-old agar slant culture stained with Maneval's method for flagella. ×2700.

(Figure 1 from photograph by Photographic Division, College of Agriculture.)

(Figures 2, 3 and 4 from photomicrographs by the Philippine Bureau of Science, Manila.)

Plate V

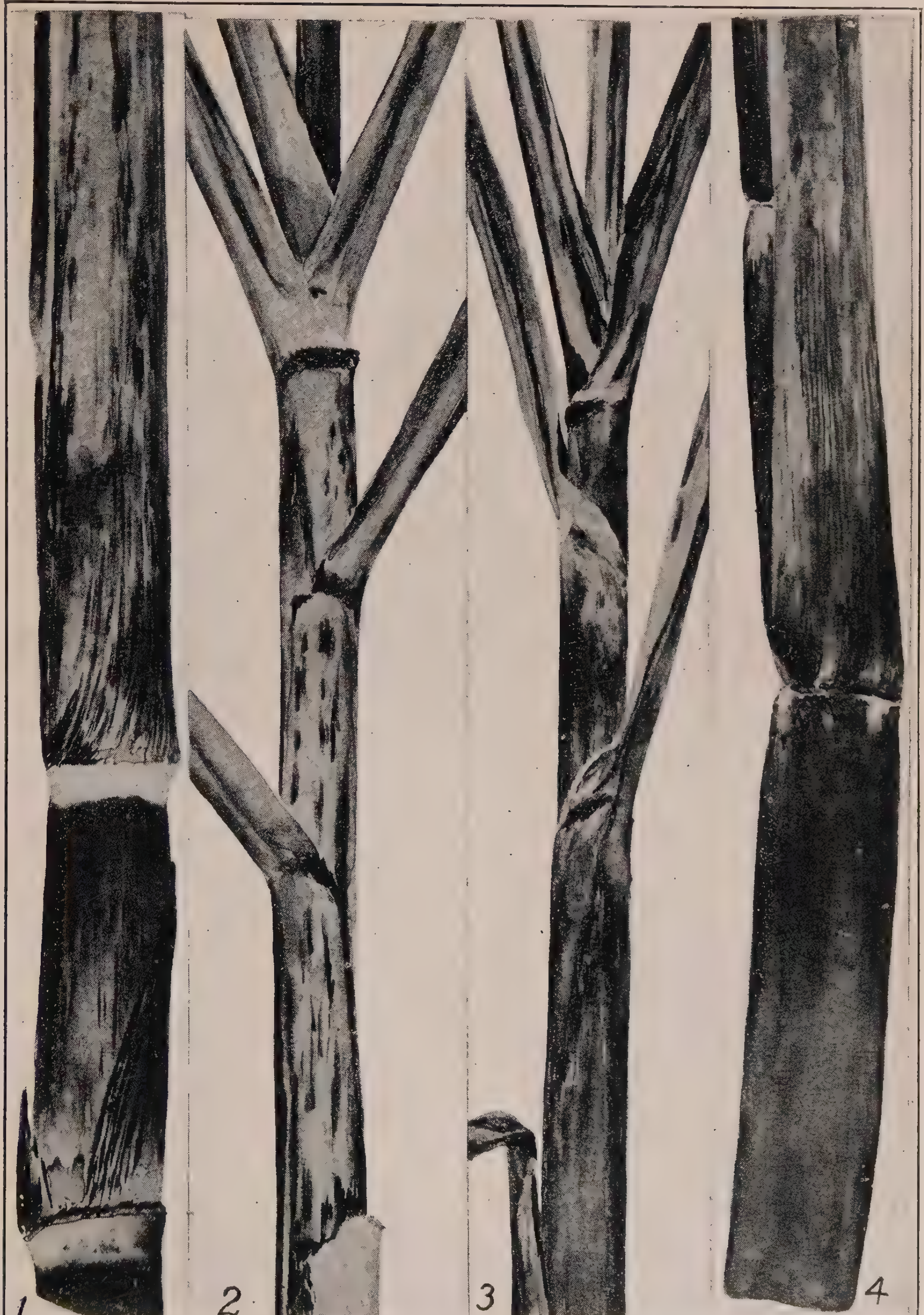
Fig. 1. Surface colony of *Bacillus sacchari* Roldan showing the internal structure and the margin as indicated by the arrow heads. ×350.

Fig. 2. Surface and buried colonies of *Bacillus sacchari* Roldan on poured plate agar, two days old. ×100.

Fig. 3. Cells from the cross section of the internode of diseased hybrid seedling cane with bacteria within the cell as indicated by (X). ×300.

Fig. 4. Buried colonies of *Bacillus sacchari* Roldan in poured plate agar culture, two days old. ×250.

(Photomicrographs by the Philippine Bureau of Science, Manila.)



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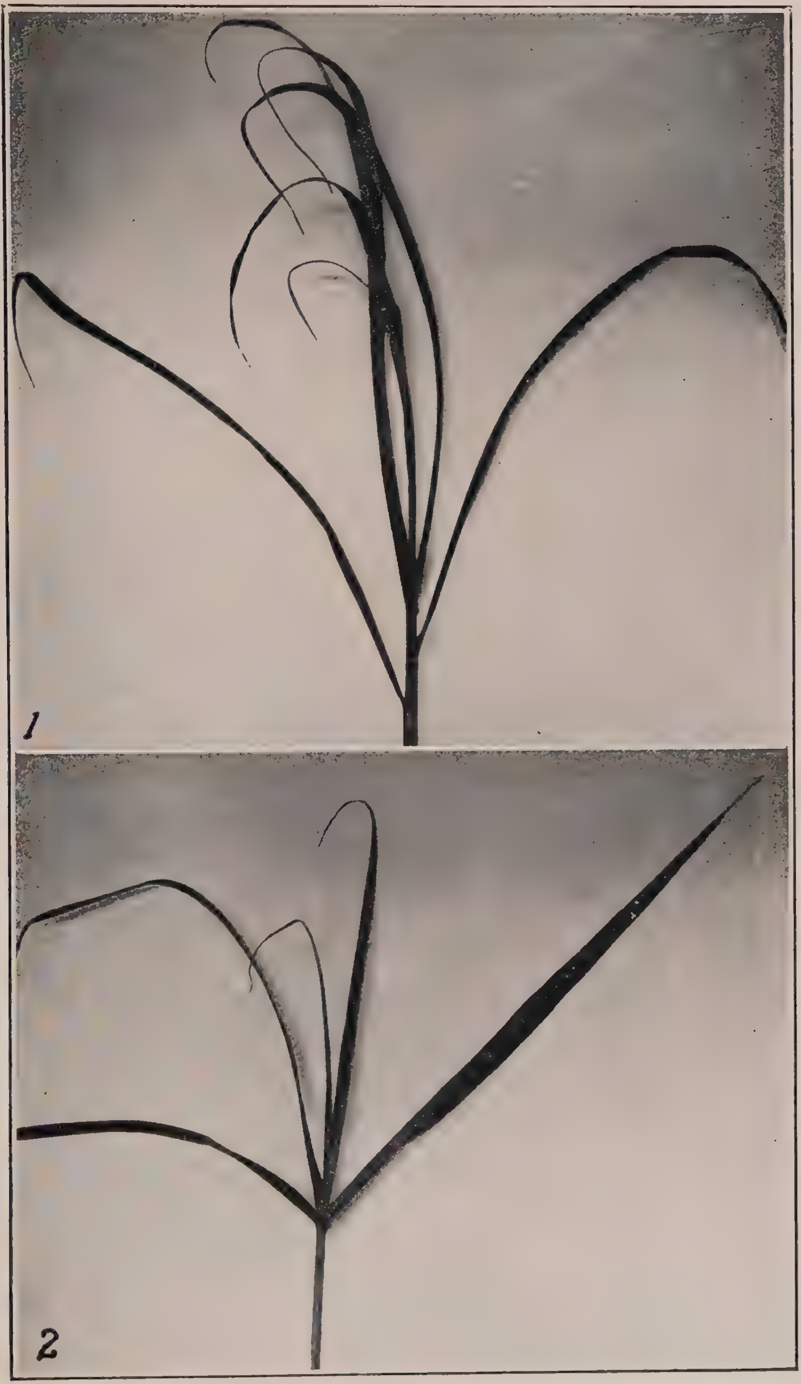

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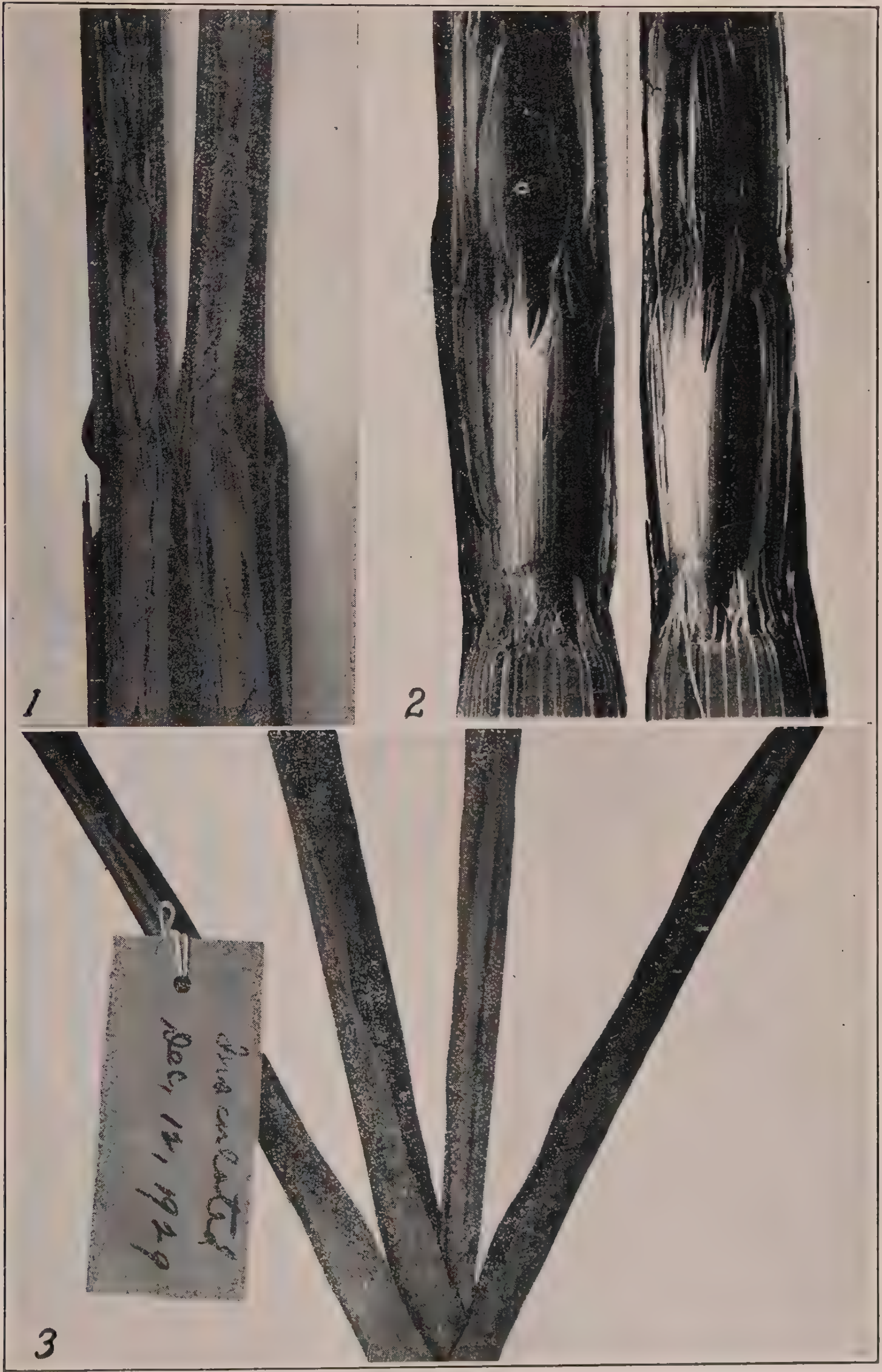
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PLATE III

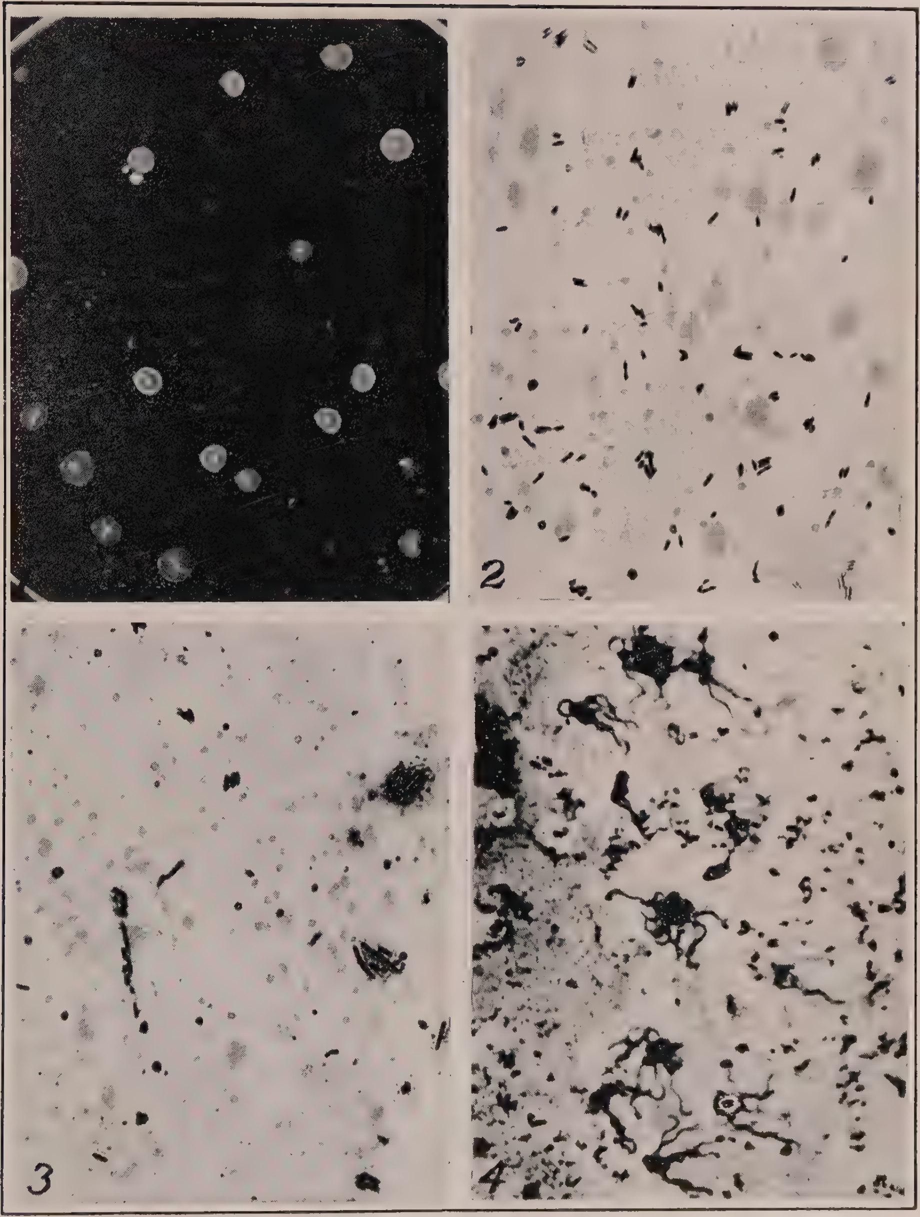

PLATE IV

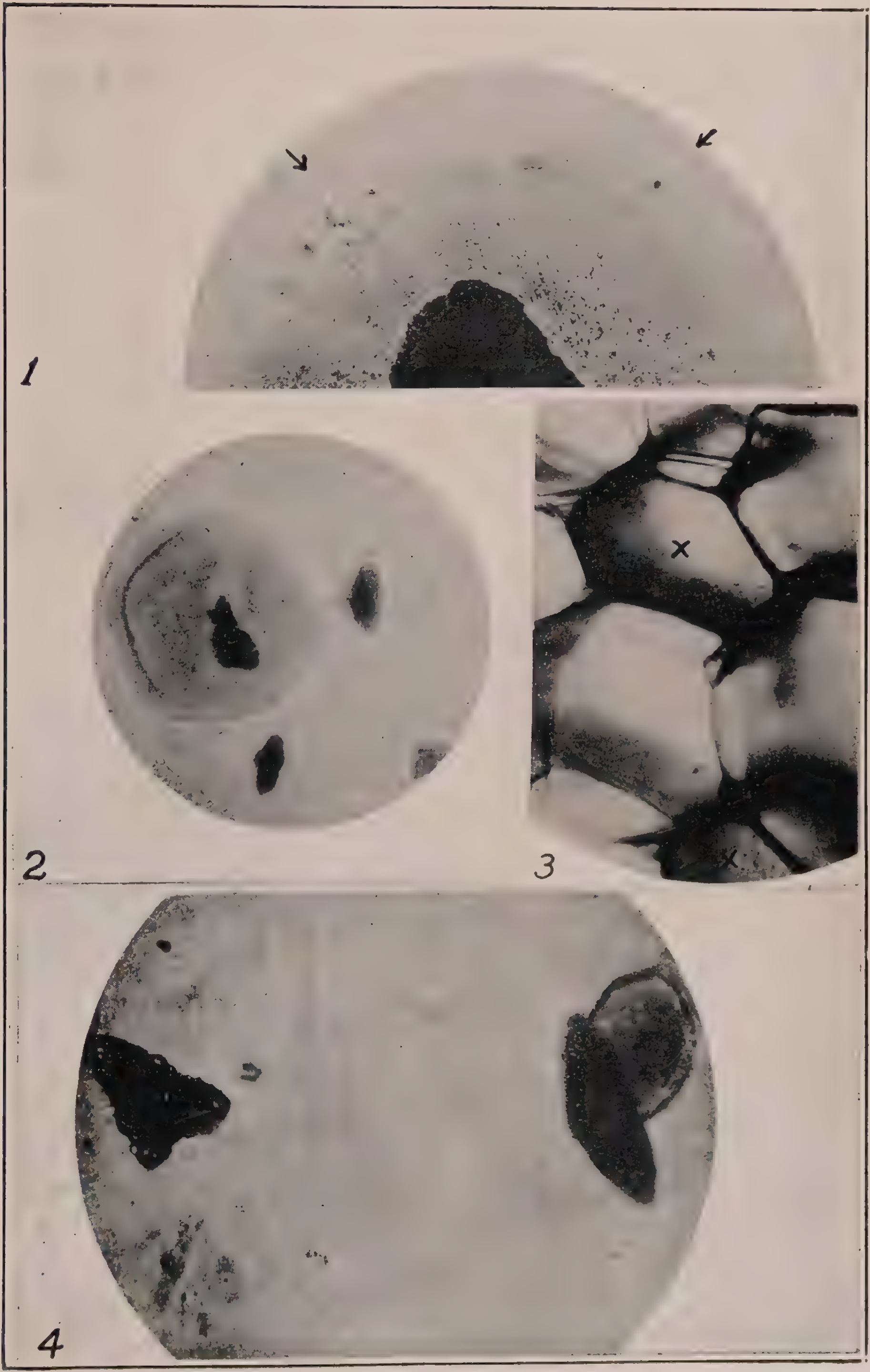

PLATE V

THE RELATION OF SOME HEAD CHARACTERS AND EGG PRODUCTION AMONG CANTONESE FOWLS[1]

F. M. FRONDA AND FELIX S. GAMO
Of the Department of Animal Husbandry

The methods generally used in eliminating the low egg layers and retaining the high ones are the trapnest and judging by certain physical characters. The use of a trapnest requires time, extra equipment and labor. If not done properly, it brings discomfort to the birds. Because of these objections to trapnesting, the method of judging by physical characters would be preferable, provided it can be proved to be as accurate or more so than trapnesting.

Extensive studies have already been made on the relation of egg production to the spread of pubic bones, conformation of the body, touch of the skin, condition of the vent, bleaching of the shanks, and on the molting habit of the bird. Among those who have made observations on the relation of pigmentation to egg production, Palmer and Marble as reported by Rice, Hall and Marble (1930) and the results of studies made by Blakeslee, Harris, Warner and Kirkpatrick (1917) and by Harris, Blakeslee and Warner (1917) may be mentioned prominently. The work of Asmundson (1921), Sherwood (1922), Hall (1923), Knox (1924), Hervey and Lewis (1924), Waters (1927), Scholten (1927) and Moore (1927) may be cited on the relation between some external body measurements of fowls and annual egg production.

Head-type characters may offer a better way of eliminating the poor layers than any other physical characters. Rice (1927) made the statement that the first and foremost important single character in judging fowls is the head. But regarding the relationship of the head characters to egg production little study has been made. Foreman (1922) was probably the first to emphasize head types among fowls. Rice and Botsford (1925) described what a good head-type should be; and still later a composite system of classifying head types based on the ideas of many of the members of the teaching staff of the Annual Cornell Poultry Judging Schools, 1918 to 1929, was adopted at Cornell University (1930). Steup (1929) classified head characters into four definite groups, based entirely upon the form and shape of the head. In this study, Steup stated that the skull does not change greatly after maturity has been reached. If this be true, selecting a hen as an egg producer by basing judgement upon the form and shape of the skull should be a fairly accurate method. An advantage of using the framework of the skull in culling is that selection may be done any part of the year, whether the hen is laying or not.

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[1] The data presented in this paper was a part of that reported by the junior author in a thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Science in Agriculture, October, 1930. Experiment Station contribution No. 739. Received for publication March 27, 1931.

In an effort to contribute something to this important question, the results of this study, the object of which was to determine whether there is any relationship existing between certain head characters of Cantonese pullets and hens and egg production is here reported. The materials used were one hundred eleven Cantonese hens and seventy-five Cantonese pullets.

Characters studied

In all, eleven characters were studied. They are the following:

Width of skull. The width of the skull was obtained by measuring the head from eye to eye with a caliper. Measuring the skull was simple, but a fixed technique had to be followed to reduce errors to the minimum. When measuring, the chicken's head was turned towards the operator, with the caliper resting on his arms parallel to the bird's eyes. Then an equal pressure was applied on the arms of the caliper until both ends lightly touched the middle part of the upper eyelids.

Distance from base of comb to top of eye. Before measuring the shortest distance from the base of the comb to the top of the eye, the standing feathers on the top surface of the skull were moistened so they would lie close to the skull, thus the base line was seen distinctly. The perpendicular distance from the base of the comb to the middle of the upper eyelid was measured with a ruler.

Distance from top of eye to nostril. The horizontal distance was measured from the inner canthus of the eye to the back edge of the nostril.

Distance from base of comb to base of wattle. In measuring the depth of the head, the operator is likely to make errors unless he has a fixed point of measurement. This depth was measured with a ruler from the base of the comb to the base of the wattle intersecting the eye at the middle.

Distance from the front edge of ear to tip of beak. The hole of the ear of the chicken is covered with feathers, so it was first located before measuring the distance from the front edge of the ear to the tip of the upper beak.

Length of beak. The length of the beak was determined by measuring from its base to its tip.

The width of beak. The width of the beak was obtained in a manner similar to that of finding the width of the skull, except that the caliper was applied at the basal portion of the beak.

Distance from base of the rear attachment of comb to the nostril. The point of the rear attachment of the comb was determined before measuring the distance from that point to the nostril.

Distance from base of comb to rear of eye. With a ruler the shortest distance was measured from the base line of the comb to the outer canthus of the eye.

Distance from base of comb to front of eye. The perpendicular distance from the base of the comb to the front of the eye was measured with a ruler from the bottom of the comb to the inner canthus of the eye.

The size of the space in the socket in front of the eyeball. The size of the orbit towards the inner canthus was obtained by measuring the distance from the front edge of the eyeball to a well marked tiny depression just in front of the eye. This character was accurately determined when the bird's eye was wide open.

RESULTS AND DISCUSSION

The results obtained in this study are summarized in table 1.

TABLE 1

Correlation of some head characters with annual egg production

SUBJECT	RELATIVE	COEFFICIENT OF CORRELATION	
		Pullets	Hens
1. Width of skull	Annual egg production	0.161 ±0.075	0.108 ±0.063
2. Distance from base of comb to top of eye	Annual egg production	-0.542 ±0.054	-0.292 ±0.057
3. Distance from top of eye to nostril	Annual egg production	-0.696 ±0.040	-0.439 ±0.051
4. Distance from base of comb to base of wattle	Annual egg production	0.539 ±0.055	0.362 ±0.063
5. Distance from front of edge of ear to tip of beak	Annual egg production	-0.212 ±0.074	0.128 ±0.062
6. Length of beak	Annual egg production	-0.146 ±0.065	-0.046 ±0.063
7. Width of beak	Annual egg production	0.351 ±0.068	0.253 ±0.059
8. Distance from base of rear attachment of comb to nostril	Annual egg production	0.007 ±0.077	0.063 ±0.063
9. Distance from base of comb to rear of eye	Annual egg production	-0.494 ±0.058	-0.503 ±0.047
10. Distance from base of comb to front of eye	Annual egg production	-0.013 ±0.077	-0.073 ±0.063
11. The size of the space in the socket in front of eyeball	Annual egg production	0.477 ±0.060	0.393 ±0.054

In the interpretation of the results obtained in this study, the interpretation of the coefficient of correlation in relation to its probable error as given by Babcock and Clausen (1927) was used as a guide. The interpretation follows:

The coefficient of correlation lies somewhere between 1.0 and -1.0; plus values indicate positive correlation and minus values indicate negative correlation. A value of +1.0 indicates perfect positive correlation; that is, an increase in one variable is attended by an exactly proportional increase in the other. Similarly a value of -1.0 indicates perfect negative correlation.

The following generalizations were considered:

(a) Values from 0.5 to 1.0 indicate high positive correlation.
(b) Values from -0.5 to -1.0 indicate high negative correlation.
(c) Values lying between 0.3 and 0.5 may be considered as moderate positive correlation, and similarly for negative values.
(d) Values from 0 to 0.3 indicate low positive correlation and corresponding minus value shows low correlation.

But the generalizations given above were in this study given this interpretation; if the value of the coefficient of correlation is less than four times its probable error, it is considered as of doubtful significance. According to King's rule, as cited by Babcock and Clausen (1927), if the coefficient of correlation is less than the probable error there is no evidence of correlation.

The figures show no correlation between the width of the skull and egg production. The correlation values are 0.161 ± 0.075 in pullets and 0.108 ± 0.063 in hens. From these results the value of the coefficient of correlation in pullets is only 1.7 times its probable error, and in hens, it is nearly twice as much. These figures indicate that no correlation exists between the two characters.

There is a marked correlation between the distance from the base of the comb to the top of the eye and egg production. The degree of correlation found between the two characters are -0.542 ± 0.054 for the pullets. Although the degree of correlation between these two characters is not as marked among hens, yet the same tendency is very apparent. These results show that the shorter the distance from the base of the comb to the top of the eye, the better is the bird as an egg layer. Steup (1929) explained that the shortness of the distance from the base of comb to the top of the eye is responsible for the flatness of the skull in a bird. A hen that is a good egg producer has a head that is flat from side to side and the eye is immediately beneath the level of the top line. The top line of the skull of the poor layer curves from side to side, so that it gives rise to a relatively wide distance between the top of the eye and the base line of the comb.

The data also show a strong correlation between the distance from the top of the eye to the nostril and egg production. The correlation coefficient is negative, being -0.696 ± 0.040 among Cantonese pullets. A similar result is shown among hens, the correlation being -0.439 ± 0.051.

This decided negative correlation, that is the shorter the distance from top of the eye to the nostril the better the hen as an egg layer, is of value in selecting a good producer. Again, Steup's (1929) second character in selecting an ideal head of a hen is the carry forward of skull toward the nostril; this is determined by the distance from the nostril to the top of the eye. The carry forward of the width of the skull is distinctly seen when the position of the eye is brought near to the nostril.

The values, 0.539 ± 0.055 and 0.362 ± 0.063, point that the coefficients of correlation between the distance from the base of the comb to the base of the wattle and egg production are positive and moderately significant. These results indicate that the greater this distance the better the hen as an egg producer. It is a matter of common knowledge among workers in poultry husbandry that the depth of the head has a marked association with the physical vigor and egg production of the bird. The less the depth of the head the poorer layer is the hen. The head of a good layer should be fine, broad, stocky and well proportioned with a lean face.

Absence of correlation between the distance from the front edge of the ear to the tip of the beak and egg production has been observed, the values of the coefficient of correlation observed being -0.212 ± 0.074 for pullets and 0.128 ± 0.062 for hens. The pullets gave low negative coefficient of correlation, whereas the hens gave positive but certainly not a significant one. The general opinion is that the long, slim head, termed, "crowheaded", indicates physical weakness, and consequently, poor laying quality.

Steup (1929) gives the balance of the head as the third character. This is estimated by the relation of the depth of the head to the distance from the front edge of the ear to the tip of the beak. Steup maintained that a good producer possesses nearly a proportional distance between these two subject characters. It had been found previously that decidedly positive correlation was present between the depth of the head and egg production. Absence of correlation between the distance from the front edge of the ear to the tip of the beak and egg production proves that, perhaps, this character is not related to egg production.

No considerable degree of correlation was obtained between the length of the beak and egg production, the coefficient being only 0.146 ± 0.065 in pullets and -0.046 ± 0.063 in hens. The fact that the coefficient of correlation obtained from the pullets is very low and the value of the coefficient of correlation is smaller than its probable error obtained from hens prove the absence of correlation between the two given characters. It is generally believed by poultry workers that a short and well curved beak is generally associated with a good layer, whereas a long sharp beak is related to a poor producer. A further study of this character among the Cantonese hens will be necessary before a definite conclusion can be made.

The coefficient of correlation between the width of the beak and egg production of 0.351 ± 0.068 for pullets and 0.253 ± 0.059 for hens, indicates low positive but significant correlations. The values of the coefficients of correlation are four and nearly five times the probable error, respectively, showing, therefore, that the relation of the two characters is significant. This agrees with the belief of many poultry cullers that a large and short beak is associated with a good hen.

No correlation exists between the distance from the base of the rear attachment of the comb to the nostril and egg production. The small values of the coefficients of correlation; namely, 0.007 ± 0.077 for pullets and 0.063 ± 0.063 for hens are conclusive evidence for this statement. On the other hand, there is a decidedly marked negative correlation between the distance from the base of the comb to rear of eye and egg production in both pullets and hens, meaning that the greater this distance the poorer is the hen or pullet as an egg producer.

Regarding the relationship between the distance between the base of the comb and the front of the eye to egg production, the data clearly show that there is no evidence of correlation between these characters. The probable error obtained from the results obtained from the pullets was even greater than the correlation coefficient. The same result was observed with the hens. Steup (1929) considers that the levelness of the head from front to rear is a very good indication of egg production. This statement was justified in this work, inasmuch as negative correlation exists between the distance from the base of the comb to the rear of the eye. But as no correlation exists between the distance from the base of the comb to the front of the eye it maybe concluded that the latter character cannot be taken as a guide in determining the levelness of the head in the Cantonese chicken.

The existence of a marked positive correlation between the space in the socket in front of the eyeball to egg production of Cantonese pullets and hens has been observed, the degree of correlation being 0.477 ± 0.060 in pullets and 0.393 ± 0.054 in hens. The result is very significant since the coefficients of correlation in both cases are about seven times their respective probable errors. Thompson (1925) gave a key related to this point. His comment was that a high producing hen presents a large prominent and wide-open eye with a considerable amount of white showing in front of the eye. From this opinion it may be deduced that the wider the area of the white visible in front of the eyeball, the better the egg production. The results obtained in this study in this particular point seem to bear out this statement.

From a practical standpoint it seems that as a result of this study the statement can be made that a good egg producer should be a bird having a flat head both from in front and back. It should have good breadth from the base of the comb to the base of the wattle. It should have a fairly wide beak at the base and it should have a roomy orbit, particularly toward the inner canthus. These are points that can be easily used in the process of culling.

SUMMARY OF CONCLUSIONS

From the results obtained in the study of correlations between certain head characters and egg production of Cantonese pullets and hens, the following summary of conclusions may be drawn:

(1) There was a very low and doubtful correlation between the width of the skull and egg production.

(2) There was a decided negative correlation between the distance from the base of the comb to the top of the eye and egg production, indicating that the shorter this distance, the better the pullet or hen as egg layer.

(3) There was a strong negative correlation existing between the distance from the top of the eye to the nostril and egg production, indicating that the greater this distance, the poorer the hen as an egg producer.

(4) There was a decidedly marked positive correlation between the distance from the base of the comb to the base of the wattle and egg production, showing that the greater this distance, the greater the tendency of the hen for heavy production.

(5) There was an absence of correlation between the distance from the front edge of the ear to the tip of the beak.

(6) There was no evidence of correlation between the length of the beak and egg production.

(7) There was a small but probably significant correlation between the width of the beak and egg production.

(8) No correlation exists between the distance from the rear attachment of the comb to the nostril and egg production.

(9) There was a marked positive correlation between the distance from the base of the comb to the rear of the eye and egg production.

(10) The correlation between the distance from the base of the comb to the front of the eye and egg production is perhaps absent in Cantonese layers.

(11) The size of the space in the socket in front of the eyeball is related to egg production. It was observed that the greater this space, the heavier the egg production of the hen.

(12) In judging the ideal head of the hen, it is advisable to use the correlated characters collectively.

(13) From the facts brought out in this study, as indicated by the coefficients of correlation in relation to their respective probable errors, it may be stated that the head of a high producer in the Cantonese hen may be expected to be flat, as indicated by the short distance from the base of the comb to the top of the eye; the eye carried forward close to the nostril; and the head rather deep and the beak broad. Also the shorter the

distance from the base of the comb to the rear of the eye and the larger the size of the space in the socket in front of the eyeball the better producer the bird may be expected to be.

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TOLERANCE OF YOUNG RICE PLANTS TO RELATIVELY LARGE AMOUNTS OF MAGNESIUM SULFATE CONTAINED IN COMPLETE CULTURE SOLUTION[1]

RAFAEL B. ESPINO AND ELEUTERIO PALISOC
Of the Department of Plant Physiology

WITH THREE TEXT FIGURES

Young rice plants apparently require a much larger amount of magnesium sulfate ($MgSO_4$) than of any of the other salts contained in a culture medium. Other plants have been found able to withstand a large amount of this salt only when the other salts in the medium are supplied in relatively large amounts. The characteristic leaf injury of wheat caused by a large amount of magnesium sulfate in the culture medium has been reported by Tottingham (1914).[2]

The apparent liking for, or tolerance of, a comparatively heavy dose of magnesium sulfate is a unique characteristic of the young rice plants of the varieties so far studied. From the standpoint of physiology and especially nutrition, or salt requirements, the case is of paramount importance. This peculiarity of the young rice plants suggests the probability that the beneficial effect is derived from the increase of the magnesium ion, or from the increase in the sulfate ion. It is also quite probable that the apparent beneficial effect is derived from the increase in the amount of magnesium sulfate, either in the culture medium or as it is absorbed by the plant from elsewhere. The last probability falls under the question of differential diffusion or absorption, and is the subject of an investigation which is now being carried out in this department.

The present study was carried out with the objects (*a*) of determining whether the beneficial effect was obtained from the salt itself, or from an increase of sulfate-ion or an increase in magnesium-ion in the culture medium, (*b*) to determine how much magnesium sulfate in the culture solution the young rice plants can stand, and (*c*) what other conditions of the culture medium might be responsible for the beneficial or harmful effects upon the rice plants.

The experiments were conducted in the experimental glass chambers of the Department of Plant Physiology at irregular intervals between the

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[1] Experiment Station contribution No. 740. Some of the data used in this paper are from the thesis presented by the junior author for graduation from the College of Agriculture, University of the Philippines, 1927.

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[2] Tottingham, W. E. 1914. A quantitative chemical and physiological study of nutrient solutions for plant cultures. Physiol. Res. **1**: 133-245.

summer of 1925 and January, 1927. The results are presented in two main lots, which for convenience are designated here as set I and set II.

MATERIALS AND METHODS

SET I

The cultures in this set were conducted to determine to what extent magnesium sulfate may be added to complete culture solutions without harm to young rice plants. These cultures were carried out first and were originally not a part of the main part of this paper. But to show the tolerance of the young rice plants to magnesium sulfate in complete culture solutions, the data obtained are here presented. After the two sets of experiments (tables 1 and 2) had been conducted, another set of four cultures each in duplicate was tried, (see table 3), the object being to find out if the best culture medium so far found, (see tables 1 and 2) could still be improved upon.

The plants and culture solutions

The cultures were prepared in a manner described on page 272 in this paper, or as was followed by Espino (1920)[3]. The culture solutions were prepared in the proportions of the main salts and in concentrations as shown in table 1. The cultures, each in duplicate, were run simultaneously for thirty days. At the end of this period the plants were harvested and data under the criteria shown in the table 1 were gathered.

In order to have more conclusive results, similar cultures were run again. Each culture was run in duplicate for thirty days. At the end of the experimental period the plants were harvested. The data obtained from these cultures are given in table 2. The culture solution so far tried that was apparently the best (see tables 1 and 2) was tried again. This time it was compared with other culture solutions that have always given good growth to young rice plants in the laboratory of plant nutrition. The exact salt proportions employed and the results obtained are shown in table 3, (see fig. 1).

SET II

This set of cultures was run with the object of determining the source of the beneficial effects the young rice plants receive when they are supplied with relatively large amounts of magnesium salt in the culture solutions. Another object was to determine whether the beneficial or the harmful effects might be due to conditions of the culture solution other than the presence of a relatively large amount of magnesium sulfate.

Seeds and seedlings

The rice seeds used in this study were Roxas and Magkompol varieties. Both are lowland varieties. The Roxas variety was furnished by the

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[3] Espino, Rafael B. 1920. Some aspects of the salt requirements of young rice plants. Philippine Jour. Sci. **16**: 455-525.

Department of Agronomy of this College, and the Magkompol variety was obtained from Batangas. It was not a part of the plan of the present investigation to use two varieties but the exhaustion of the supply of seeds of the Roxas variety in the Agronomy Department made it necessary.

The seeds for the cultures were soaked in tap water for about 24 hours, then were thoroughly washed with tap water and spread on a piece of blotting paper placed in a porcelain pan which was then covered with a piece of moist blotting paper.

Thus the seeds were germinated between two sheets of moist blotting paper. Soon after the appearance of plumule and radicle the seeds were spread on paraffined bobbinet which was stretched horizontally over the opening of a large glass vessel having a rim diameter of about 25 centimeters. Then the glass vessel was filled to the rim with tap water so that the bobbinet rested on the surface of the water nearly all the time. The amount of water was maintained by frequent additions.

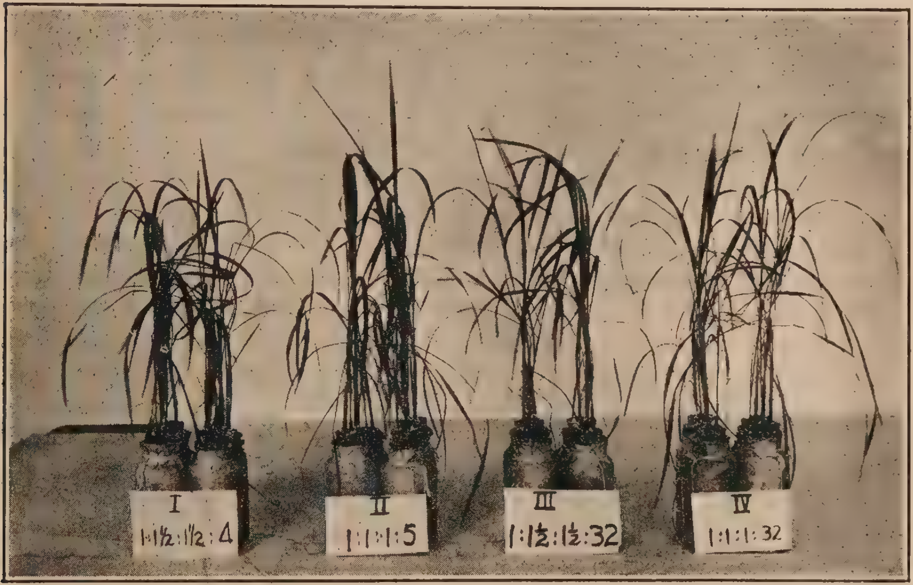

Fig. 1.—Showing the tolerance of the young rice plants to large amounts of $MgSO_4$ in the culture media.

When the shoot was about six centimeters high, apparently healthy and uniformly developed seedlings were selected for the cultures. These seedlings were transferred to the nutrient solution, by fixing each of them in a perforated cork stopper with a cotton plug, so that only their roots could be in the solution. The cork stoppers were hollowed out at the bottom and had three holes each for holding the seedlings—one seedling to a hole.

The culture solutions

Single-salt stock solutions. The salts used for the cultures were first prepared singly in M/10 concentration. These salts were "Baker analysed" monopotassium phosphate, KH_2PO_4; calcium nitrate, $Ca(NO_3)_2$; magnesium sulfate, $MgSO_4$; ammonium sulfate $(NH_4)_2SO_4$; magnesium nitrate $Mg(NO_3)_2$; monomagnesium phosphate $MgH_4(PO_4)_2.H_2O$ and a little ferric phosphate suspension. Distilled water was used as the solvent of all these salts.

Culture solution. Whenever needed, whether to start a culture series or to renew a solution, the culture solution was prepared. The culture solutions were prepared according to the proportions and concentrations of the various media shown in table 4. Each solution was prepared as follows: A one-liter volumetric flask was filled with about 500 cc. of distilled water and into this the required amount of each of the salts was added separately, shaking the flask at the same time to insure the even distribution of the salts and thus avoiding the formation of precipitates. Then distilled water was added until the solution was up to the mark on the neck.

Sixty-five cubic centimeters of this solution was used as a culture medium placed in a glass bottle about 8 centimeters high and with a gross diameter of 4 centimeters. The rest of the solution was either used at once or was kept for use in renewing the culture medium. Each culture lasted for 21 days and renewal of each solution was made at intervals of three days. To supply the young rice plant with iron, a few drops of ferric phosphate suspension was added to each culture solution.

Each culture was run in duplicate. Two trials were run for each salt series, except the control series in which four trials were made. Thus, in the two trials 48 bottles were used for each salt series, and for the control series only 24 bottles were used. Three salt series were run at the same time so that in a given experimental period 54 bottles were used simultaneously; 24 bottles for each of the two salt series and 6 bottles for the control. To keep the root in darkness as much as possible, each bottle was wrapped with a piece of carbon paper reinforced with a piece of Manila paper.

The three salt series of nutrient solutions and the proportions of the component salts of each are shown in table 4. The culture series may be described briefly as follows:

Magnesium nitrate. This was a combination of monopotassium phosphate, ammonium sulfate, calcium nitrate, and magnesium nitrate; with magnesium nitrate in varying amounts (see table 4).

Monomagnesium phosphate. This was a combination of monopotassium phosphate, ammonium sulfate, calcium nitrate, and monomagnesium phosphate; monomagnesium phosphate in varying amounts (see table 4).

Magnesium sulfate. This was a combination of monopotassium phosphate, ammonium sulfate, calcium nitrate, and magnesium sulfate in the proportion of these salts shown in table 4.

EXPERIMENTS AND RESULTS FOR SET II

The plants used in this study were kept in the glass chamber of the laboratory of Plant Physiology of this College where they would receive intense diffuse sunlight during the morning hours and direct rays of the sun in the afternoon, whenever the weather was clear. The bottles were placed far apart, and were arranged in such a way that all would receive about the same amount of sunlight, thus avoiding border effect on the growth of the plants. The cultures were frequently interchanged in position.

In the magnesium nitrate and magnesium phosphate series, there were six cultures which were not run in the first trial (two cultures in each group), and another six cultures which were not run in the second trial. The reason for this was that in the first trial when the heaviest yield of dry weight of plants was produced by those growing in the highest concentrations in each group, (see table 4, A, B, C groups), additional solutions of still higher concentrations were run. This was done so as to find the optimum concentration best for the growth and development of rice plants. The two lowest concentrations in each group ran in the first trial that produced rather poorly developed plants were not included in the second trial. They were replaced in each group by two cultures with concentrations higher than any culture employed in the first trial.

To determine the relative beneficial effects of the different media upon the growth and development of the young rice plant, the following criteria of results were employed:

External appearance of plants. The external appearance of the plants was carefully noted from time to time. The color of the leaves and of the stalks was noted, together with any injury to any part of the plant. The observations were recorded but only those for the selected cultures (the best from each salt series) are here given, (see table 5). At the end of each experimental period, representative cultures of the different concentrations were selected and photographed (see fig. 2 and 3).

Height of shoot and length of root. Before harvesting the plants at the end of an experimental period, the length of the roots and of the top of each culture was measured separately. The data thus obtained were compared and only those that were from the best culture from each salt series are presented, (see table 5).

Dry weight of plants. At the end of each experimental period, the plants were harvested, wrapped in paper separately by cultures, and then dried thoroughly in an electric oven at a temperature of between 100 and 105°C. Then they were weighed in an analytical balance. The dry weights of the plants (tops and roots) from the best culture from each salt series are recorded in table 5.

DISCUSSION OF RESULTS

Tolerance of young rice plants to magnesium sulfate in complete culture solution

Examination of the data in tables 1 and 2 shows that culture IV, which was characterized by having 1 part of KH_2PO_4, 1½ parts each of $(NH_4)_2SO_4$ and $Ca(NO_3)_2$ and 32 parts of $MgSO_4$, with a total concentration of 0.009 gram-molecule (of all the salts taken together) per liter of the solution, gave the highest yield data under practically all the criteria employed. When the amount of $MgSO_4$ was either increased or decreased, although the other salts remained the same, there was almost always a decrease in yield of the young rice plants. It should be admitted, however, that all the cultures reported in tables 1 and 2, produced well developed plants—normal in every respect, except that the plants in culture IV were just slightly better than the rest.

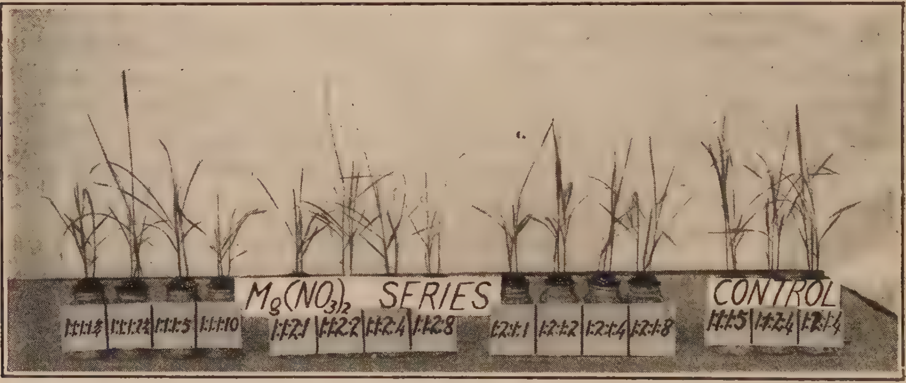

Fig. 2.—Young rice plants grown in the $Mg(NO_3)_2$–series as compared with those in the $MgSO_4$–series (or control).

To experimentally determine if the culture IV just described could still be improved upon for the young rice plants, another set of cultures was tried. This time only four cultures were included (see table 3). The results show that a better culture solution or a better salt proportion was found for the young rice plant. The new culture solution was characterized by having 1 part each of KH_2PO_4, $(NH_4)_2SO_4$, and $Ca(NO_3)_2$ and 32 parts of $MgSO_4$, with a total concentration of 0.00875 gram-molecule (of all the salts taken together) per liter of the solution. In this new culture solution, the $MgSO_4$ was again in a relatively very large amount, being 32 parts. The other salts used were of the same kind and quantity as those contained in a culture solution found by Espino in 1920 to be the best for the young rice plant. However, the highest amount of $MgSO_4$ then tried by him was only 5 parts. As shown by the data in table 3, new culture medium (culture II in table 3) was far superior to Espino's best 4-salt type A, (culture IV in table 3), in which the $MgSO_4$ present was only about one-sixth of that present in the new culture medium,—plainly indicating the liking of young rice plants for, or the tolerance of, a strikingly large amount of $MgSO_4$ in a complete culture solution.

Comparing nutritive values of various magnesium salts—precautions taken

For the proper understanding of the results of this study it should be said that in attempting to solve the problems, a substitution method was employed. A radical attached to one metal was substituted for another radical and a metal with one radical was substituted for another metal attached to the same kind of radical in Espino's best solution of 4-salt type A, which was employed in this study as the control. For example, in the magnesium nitrate series, all the salts in Espino's best solution of 4-salt type A were included except the magnesium sulfate, which was replaced by magnesium nitrate. The same method of substitution was used in the magnesium phosphate series, (see table 4).

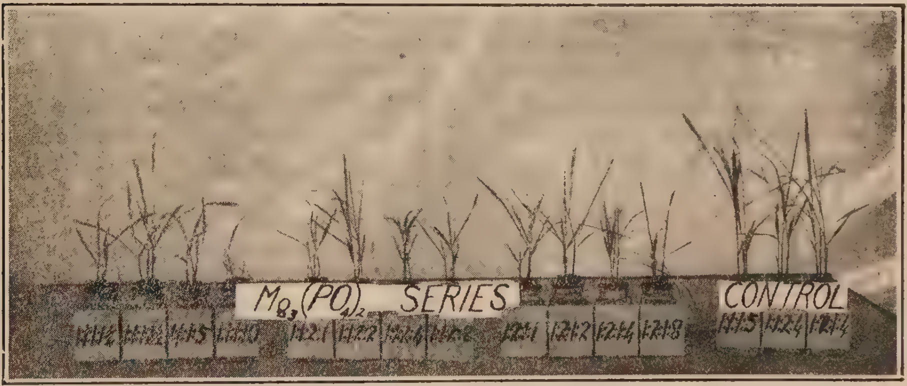

Fig. 3.—Young rice plants grown in the $MgH_4(PO_4)_2.H_2O$–series as compared with those in the $MgSO_4$–series (or control).

It should be stated also that care was taken that in the process of substitution no element essential for the normal growth and development of plants was omitted, nor was an element or elements not included in Espino's best solution of 4-salt type A, introduced.

As a basis for comparison on the determination of the relative nutritive values of the different salt series as indicated by, (*a*) the external appearance of the plants; (*b*) the length of roots; (*c*) the height of tops; and (*d*) dry weight of the plants, three of Espino's 4-salt type A solutions were used. The solution of the 4-salt type A, which Espino found best suited for the young rice plants, (variety Wateribune), was included. These three control cultures may also be considered as one salt series,—the magnesium sulfate series. The different salt series were first studied separately and the culture solution found best in each series is used in comparing the relative nutritive values of the different salt series studied. Also, these selected cultures will here be employed in an attempt to determine what it is that makes the young rice plants grow well when supplied with a comparatively large amount of $MgSO_4$ in complete culture solution.

The cultures in the magnesium nitrate series

In all the cultures in the magnesium nitrate series (for lack of space, only the data in table 5 are here presented), and irrespective of the total concentrations of the solutions and of the proportions of the component salts, the plants grown therein were invariably stunted in growth and had pale green leaves. This peculiarity was observed in the first trial and also from the results in the second. It was particularly in the cultures containing a higher partial concentration of $Mg(NO_3)_2$ that this injury was strikingly observed.

Arbitrarily selecting the cultures yielding the three consecutive highest records on each of: (*a*) the height of top; (*b*) length of root; and (*c*) the weight of dry plants, we find that the best culture was the C-$Mg(NO_3)_2$-3. This culture was characterized by having 1 part KH_2PO_4; 2 parts $(NH_4)_2SO_4$; 1 part $Ca(NO_3)_2$ and 4 parts $Mg(NO_3)_2$ with a total concentration of 0.002 gram-molecule (of all the salts taken together) per liter.

The cultures in the monomagnesium phosphate series

Of the twenty-four duplicate cultures which were tried twice, the culture designated C-$MgH_4(PO_4)_2.H_2O$-2 was found to be the best, (see fig. 3, also table 5). In both trials, this culture was found to have produced the tallest plants with the highest dry weight. It was characterized by having 1 part KH_2PO_4; 2 parts $(NH_4)_2SO_4$; 1 part $Ca(NO_3)_2$; and 2 parts $MgH_4(PO_4)_2.H_2O$, with a total concentration of 0.0015 gram-molecule (of all the salts taken together) per liter. However, it should be remembered that while this culture was found to be the best in the lot, yet it did not produce normally developed plants, (see fig. 3). In fact, the plants from all the cultures had leaves which were dried at the tips.

Nutritive values of ammonium salts and of magnesium salts

To make possible the comparison of the nutritive values of the ammonium salts and of magnesium salts employed, the data for the best culture solution of each salt series in each of the two trials here employed are given in table 6. These data were not all gathered at the same time. However, precautions were always taken to use control cultures (Espino's best 4-salt solution, type A), whenever a set of cultures was run. Because of this precaution, it was possible to compare the data in table 6 and thereby determine definitely the relative nutritive values of the best culture solution from each of the different magnesium and ammonium salts series here studied. With the data obtained from the control cultures arbitrarily taken as 100, the other data were reduced relatively.

Examination of the data in table 6 will show that in terms of an average of the data (under each criterion) obtained from the two trials, the relative nutritive values of the best cultures from the different salt series NH_4NO_3, $NH_4H_2PO_4$, $Mg(NO_3)_2$, and $MgH_4(PO_4)_2 \cdot H_2O$, are arranged in the descending order as the salts are here listed. The control, which was considered as $(NH_4)_2SO_4$ series, or as $MgSO_4$ series, proved not as good a culture medium as the culture B-(NH_4NO_3)-4 or B-$(NH_4H_2PO_4)$-4, in terms of height of tops, length of roots, and dry weight of tops and roots. But on the basis of the external appearance of the plants, the B-$(NH_4H_2PO_4)$-4 produced plants with dried leaf tips, whereas the plants from the control culture were perfectly well developed. Like the control, the culture solution B-(NH_4NO_3)-4 produced plants normal in every respect; but as was stated this culture solution was better than the control.

Further study of the data in table 6 will show that the presence in almost any amount of either $NH_4H_2PO_4$ or $MgH_4(PO_4)_2 \cdot H_2O$ in the culture solution almost invariably led to the development of this young rice plants with dried leaf tips. This type of leaf injury was also observed by the senior author (1920) when he grew young rice plants in complete culture solutions in which the calcium was supplied as $Ca(H_2PO_4)_2 \cdot H_2O$. In the different salts of magnesium, the $MgSO_4$ was always the best and the $Mg(NO_3)_2$, as well as the $MgH_4(PO_4)_2 \cdot H_2O$ in any amount, produced leaf injury,—drying of the tips of the leaves.

Large amounts of magnesium sulfate preferred by young rice plants

The apparent ability of the young rice plants to grow and develop well in culture solutions containing relatively large amounts of magnesium sulfate is interesting, to say the least, and is not the peculiarity of any other plants so far grown in nutrient solutions. This peculiarity was first observed and reported by Espino in 1920. It has been repeatedly confirmed by the students of plant nutrition in this college since 1924, and lastly and conclusively confirmed by the results obtained from the present study, (see tables 1, 2, and 3 and fig. 1). It was found possible to produce normally developed young rice plants when these were supplied with $MgSO_4$ as much as 0.008 molar. In fact, the best results were obtained from the culture solution containing, in addition to the other salts, which Espino (1920) employed, $MgSO_4$ in this amount.

With the mass of evidence pointing to this special peculiarity of the young rice plant, it was considered of interest to find whether the beneficial effects or excellent growth and development of the young rice plant referred to above, apparently occasioned by the heavy application of magnesium sulfate, was obtained from the salt itself, or from an increase of the sulfate-ion or from the increase of magnesium-ion in the nutrient medium. By the substitution method this determination was made. In addition to monopotassium phosphate and calcium nitrate which were used in each culture solution in a fixed amount , magnesium-salts and ammonium-salts[4] were added. The cultures that were used contained the following magnesium and ammonium-salts:

(a) $MgSO_4$ and $(NH_4)_2SO_4$
(b) $MgSO_4$ and $NH_4H_2PO_4$
(c) $MgSO_4$ and NH_4NO_3
(d) $Mg(NO_3)_2$ and $(NH_4)_2SO_4$
(e) $MgH_4(PO_4)_2.H_2O$ and $(NH_4)_2SO_4$

In studying the nutritive merits of the complete culture solutions containing these five special salt combinations, the data in table 6 should be consulted. The data in this table show that the combination $MgSO_4$ and $(NH_4)_2SO_4$ was used in the control cultures and supplied in relatively large amounts each of *(a)* the salt, $MgSO_4$, *(b)* the Mg-ion, and *(c)* the SO_4-ion; the last named ion is derived from the Mg-salt as well from the NH_4-salt. The plants grown in this solution were perfectly normal,—a fact which seems to point out that the beneficial effect was really derived from the use of a relatively large amount of $MgSO_4$, but it is not yet possible to point out from where the beneficial effect came.

Beneficial effects not derived from an increase of SO_4-ion

The culture solutions in which the combination $MgSO_4$ and $NH_4H_2PO_4$ was used, almost invariably produced fairly good plants but with leaves dried at the tips. The culture solution (see table 6, and refer back to table 4 for salt proportions), that gave the highest yield as dry weight had salt proportions as follows: 1 part KH_2PO_4; 4 parts $NH_4H_2PO_4$; 2 parts $Ca(NO_3)_2$; and 4 parts $MgSO_4$. It may therefore be suspected that the beneficial effect derived from the $MgSO_4$ also asserts itself in this culture and that the increase of SO_4-ion was not responsible for the good growth of the plant, as in this solution there was a decrease of SO_4-ion owing to the substitution of $NH_4H_2PO_4$ for the $(NH_4)_2SO_4$. The leaf injury was probably due to the relatively large amount of PO_4-ion or to the H-atoms in both phosphate bearing salts.

Morever, when the use of the large amount of $MgSO_4$ was accompanied by a relatively large amount of NH_4NO_3, the plants grown in the culture medium were the most vigorous and most normally developed in every respect. This result was even better than that obtained from the control culture in which the largest amount of SO_4-ion was used. This evidence, therefore, seems to point out more emphatically than in the case just discussed that the beneficial effect the young rice plants derived from the heavy application of $MgSO_4$ is undoubtedly not from the large amount of SO_4-ion in the nutrient solution, because in the culture in which NH_4NO_3 was used there was apparently a decrease in the SO_4-ion. Of the three possible sources (the $MgSO_4$, the Mg-ion, or the SO_4-ion) of the benefits which the young rice plant derives from the use of $MgSO_4$ in large amounts, the SO_4-ion possibility is eliminated, as in this culture there was a decrease of the sulfate-ion owing to the substitution of NH_4NO_3 for $(NH_4)_2SO_4$ in the control. Therefore, the new question now is: Is the beneficial effect already referred to derived from an increase of Mg-ion or of $MgSO_4$ itself?

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[4] The main results obtained with the use of the ammonium salts were used by the junior author in writing an article, "Comparative nutritive values of different salts of ammonium" (*see* THE PHILIPPINE AGRICULTURIST. 17: 37-43. 1928). However, for comparison and in order that the present discussion be clear and conclusive the best culture from each of the three ammonium salt series, is quoted in table 5.

Beneficial effects not due to increase of Mg-ion

The first alternative, the rôle played by the Mg-ion, will now be considered. Consulting the data in tables 5 and 6 it may be found that the plants grown in the culture solutions containing the salt combination $Mg(NO_3)_2$ and $(NH_4)_2SO_4$ and in the cultures in which $MgH_4(PO_4)_2.H_2O$ and $(NH_4)_2SO_4$ were added were abnormally developed. The plants were stunted in growth and had chlorotic leaves. Whenever either the $Mg(NO_3)_2$ or the $MgH_4(PO_4)_2.H_2O$ was used, in amounts equal to or more than the amount of $MgSO_4$ in the control cultures, the stunted growth and chlorotic appearance of the plants became more pronounced. Thus, it becomes evident that the apparent beneficial effect which a large application of $MgSO_4$ gave to the young rice plant was not due to increase of Mg-ion in the culture medium, because when the same amount of Mg-ion but attached to a radical other than the SO_4 was used, the results were as described—short and chlorotic plants.

Beneficial effects due to $MgSO_4$ itself

In view of the foregoing discussions it becomes evident that the heavy application of Mg-ion is beneficial to the young rice plant only when it is attached to the SO_4-ion or radical; hence, $MgSO_4$.

However, as is usually true in scientific studies, new questions come up as soon as the old ones are answered. So in the present study a new aspect of the problem presents itself. This question is in connection with the use of $Mg(NO_3)_2$ and of $MgH_4(PO_4)_2.H_2O$ in culture media. With the use of these salts, the NO_3-ion and the PO_4-ion were increased. It may then be pertinently asked: Is the failure of the young rice plants to develop normally when grown in the culture solution containing either one of these salts due to the increase in the culture medium of the ions of either of these salts?

In reply, it may be pointed out that there are certain indications that the harmful effect just referred to may not have been due to the increase of the NO_3-ion and of PO_4-ion, because normally developed plants were obtained from the culture solutions in which the PO_4-ion supplied as $NH_4H_2PO_4$ and the NO_3-ion supplied as NH_4NO_3 were increased in separate nutrient solutions. In fact, better looking plants were obtained when NO_3-ion was increased following the use of the nitrate of ammonium instead of the sulfate of ammonium, (see table 6).

Harmful effects on the young rice plants

In the first part of this study (set I) care was taken to employ only those culture solutions the KH_2PO_4, $(NH_4)_2SO_4$ and $Ca(NO_3)_2$ contents of which were those found by the senior author (1920) to be conducive to normal growth of the young rice plants. Thus, if any harmful effects are shown at all, (see tables 1, 2 and 3) these were so slight that they could be considered negligible. Real harmful effects in the form of dried leaf tips, were observed from culture V (tables 1 and 2) in which an exceptionally large amount of $MgSO_4$ was used.

Defective growths of the plants were also observed in those cultures, (see tables 5 and 6) supplied with a magnesium salt other than $MgSO_4$. In all of these cultures not supplied with $MgSO_4$, certain characteristic physical defects were seen,—either stunted growth of the plants or plants with leaves chlorotic and dried at the tips, in some cases both defects were found in the same cultures. Of course the senior author in 1920 observed defective growths of the young rice plants in those culture media relatively liberally supplied with either KH_2PO_4, $Ca(NO_3)_2$ or $(NH_4)_2SO_4$. However, this not being the major problem in the present study, no attempt was made to include culture solutions found by Espino (1920) to be harmful to the young rice plants.

SUMMARY AND CONCLUSIONS

1. Better plants were produced when the $MgSO_4$ in the original Espino's best 4-salt solution was increased eight times. A new culture solution was therefore found containing 1 part KH_2PO_4, 1 part $(NH_4)_2SO_4$, 1 part $Ca(NO_3)_2$ and 32 parts $MgSO_4$ with a total concentration of 0.00875 gram-molecule (of all the salts taken together) per liter.

2. The apparent beneficial effect derived by young rice plants from Espino's best culture solution of 4-salt type A, was not only due to the introduction of ammonium sulfate, but also to the heavy application of magnesium sulfate.

3. The possible source of the beneficial effect derived by the young rice plants from the heavy application of magnesium sulfate in Espino's 4-salt solution was not the increase of Mg-ion or of SO_4-ion, but the increase of $MgSO_4$ itself.

4. Of the different magnesium salts, $Mg(NO_3)_2$ and $MgH_4(PO_4)_2.H_2O$ when used in rather large amounts, always produced plants with leaves chlorotic and dried at the tips. Magnesium sulfate ($MgSO_4$) was not toxic to the young plant.

TABLE 1

Showing the salt contents of the culture media employed and the relative results obtained as influenced by the different amounts of magnesium sulfate ($MgSO_4$) in the media

CULTURE NO.	SALT PROPORTIONS: GRAM-MOLECULE OF EACH SALT PER LITER				LENGTH				DRY WEIGHT[b]				EXTERNAL APPEARANCE OF PLANTS
					Tops		Roots		Tops		Roots		
	KH_2PO_4	$(NH_4)_2SO_4$	$Ca(NO_3)_2$	$MgSO_4$	a	b	a	b	a	b	a	b	
					cm.	*cm.*	*cm.*	*cm.*					
I[a]	.00025	.000375	.000375	.001	33.4	33.8	21.5	25.0	69	80	62	100H	a– Normal green. b– Normal green.
II	.00025	.000375	.000375	.002	35.5	36.0	23.5	21.5	74	94	73	96	a– Normal green. b– Normal green.
III	.00025	.000375	.000375	.004	37.5	35.5	25.5	25.0	80	97	83	93	a– Normal green. b– Normal green.
IV	.00025	.000375	.000375	.008	39.0H	36.5	27.5H	25.5H	100H	81	100H	74	a– Normal green. b– Normal green.
V	.00025	.000375	.000375	.016	36.2	44.0H	23.0	21.0	89	100H	71	87	a– Normal green. b– Tips of older leaves dry.

[a] This culture had not been tried before, *see* Espino, (1920).

[b] The data are in relative values; the highest actual value under either (*a*) or (*b*) was arbitrarily given the value of 100, the other actual values were reduced relatively.

TABLE 2

Showing the salt contents of the culture solutions employed and the results[a] *obtained as influenced by the amounts of magnesium sulfate in the solutions*
(A repetition of the experiments reported in table 1)

CULTURE NO.	SALTS USED: IN GRAM-MOLECULE PER LITER OF CULTURE SOLUTION		HEIGHT OF TOPS	LENGTH OF ROOTS	DRY WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
I	KH_2PO_4 $Ca(NO_3)_2$ $(NH_4)_2SO_4$ $MgSO_4$	0.00025 0.000375 0.000375 0.001	89	89	94	95	94	Plants well developed.
II	KH_2PO_4 $Ca(NO_3)_2$ $(NH_4)_2SO_4$ $MgSO_4$	0.00025 0.000375 0.000375 0.002	95	90	94	95	94	Plants well developed.
III	KH_2PO_4 $Ca(NO_3)_2$ $(NH_4)_2SO_4$ $MgSO_4$	0.00025 0.000375 0.000375 0.004	95	79	91	87	91	Plants well developed.
IV	KH_2PO_4 $Ca(NO_3)_2$ $(NH_4)_2SO_4$ $MgSO_4$	0.00025 0.000375 0.000375 0.008	100 (39.9 grams)	100 (19.9 grams)	100 0.267 gram)	100 (.039 gram)	100 (.306 gram)	Plants well developed.
V	KH_2PO_4 $Ca(NO_3)_2$ $(NH_4)_2SO_4$ $MgSO_4$	0.00025 0.000375 0.000375 0.016	98	75	95	92	95	Plants similar to plants in I to IV, except that some leaf tips were rolled.

[a] The data are in relative values; the highest actual value under either (*a*) or (*b*) was arbitrarily given the value of 100, the other actual values were reduced relatively.

TABLE 3

Showing the comparative results obtained from four types of culture solutions—having slightly different salt proportions (Each trial was in quadruplicate cultures)

CULTURE NO.	SALTS USED: IN GRAM-MOLECULE PER LITER OF CULTURE SOLUTION	TRIAL[a]	AVERAGE HEIGHT OF PLANTS	AVERAGE LENGTH OF LONGEST ROOTS	DRY WEIGHT[b]			APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
			cm.	*cm.*				
I	KH_2PO_4 .00025 $(NH_4)_2SO_4$ .000375 $Ca(NO_3)_2$ .000375 $MgSO_4$ .008	a	36.0	16.8	78	63	78	All the plants were well developed.
		b	35.2	14.9	68	80	70	
II	KH_2PO_4 .00025 KH_2PO_4 .00025 $(NH_4)_2SO_4$ .00025 $Ca(NO_3)_2$ .00025 $MgSO_4$ .008	a	41.4	18.9	100 (1.281 grams)	100 (.182 gram)	100 (1.463 grams)	
		b	37.9	15.8	90	95	91	
III	KH_2PO_4 .00025 $(NH_4)_2SO_4$ .000375 $Ca(NO_3)_2$ .000375 $MgSO_4$ .001	a	40.3	16.8	91	76	93	All the plants were well developed.
		b	36.9	17.5	79	70	79	
IV	KH_2PO_4 .00025 $(NH_4)_2SO_4$ .00025 $Ca(NO_3)_2$ .00025 $MgSO_4$ .00125	a	38.0	16.6	79	69	84	
		b	36.6	14.3	72	74	73	

[a] All cultures under trial *a* were run at the same time; those under *b*, at another time.

[b] The data under this criterion are in *relative values*. The highest *actual value* was arbitrarily given the value of 100 and the rests of the *actual values* were reduced relatively.

TABLE 4

Salt proportions and total concentrations of all the culture solutions

SALT SERIES	CULTURE DESIGNATION		SALT PROPORTIONS: GRAM-MOLECULE OF EACH SALT PER LITER				CONCENTRATION OF CULTURE SOLUTION: GRAM-MOLECULE OF ALL SALTS TAKEN TOGETHER PER LITER
			KH_2PO_4	$(NH_4)_2SO_4$	$Ca(NO_3)_2$	$Mg(NO_3)_2$	
Magnesium nitrate	A–$Mg(NO_3)_2$	–1	.00025	.00025	.00025	.0003125	0.0010625
		–2	.00025	.00025	.00025	.000625	0.001375
		–3	.00025	.00025	.00025	.00125	0.002
		–4	.00025	.00025	.00025	.0025	0.00325
		–5	.00025	.00025	.00025	.005	0.00575
	B–$Mg(NO_3)_2$	–1	.00025	.00025	.0005	.00025	0.00125
		–2	.00025	.00025	.0005	.0005	0.0015
		–3	.00025	.00025	.0005	.001	0.002
		–4	.00025	.00025	.0005	.002	0.00375
		–5	.00025	.00025	.0005	.004	0.005
	C–$Mg(NO_3)_2$	–1	.00025	.0005	.00025	.00025	0.00125
		–2	.00025	.0005	.00025	.0005	0.0015
		–3	.00025	.0005	.00025	.001	0.002
		–4	.00025	.0005	.00025	.002	0.00375
		–5	.00025	.0005	.00025	.004	0.005
			K_2PO_4	$(NH_4)_2SO_4$	$Ca(NO_3)_2$	$MgH_4(PO_4)$	
Magnesium phosphate	A–$MgH_4(PO_4)_2$	–1	.00025	.00025	.00025	.0003125	0.0010625
		–2	.00025	.00025	.00025	.000625	0.001375
		–3	.00025	.00025	.00025	.00125	0.002
		–4	.00025	.00025	.00025	.0025	0.00325
		–5	.00025	.00025	.00025	.005	0.00575
	B–$MgH_4(PO_4)_2$	–1	.00025	.00025	.0005	.00025	0.00125
		–2	.00025	.00025	.0005	.0005	0.0015
		–3	.00025	.00025	.0005	.001	0.002
		–4	.00025	.00025	.0005	.002	0.00375
		–5	.00025	.00025	.0005	.004	0.005
	C–$MgH_4(PO_4)_2$	–1	.00025	.0005	.00025	.00025	0.00125
		–2	.00025	.0005	.00025	.0005	0.0015
		–3	.00025	.0005	.00025	.001	0.002
		–4	.00025	.0005	.00025	.002	0.00375
		–5	.00025	.0005	.00025	.004	0.005
			KH_2PO_4	$(NH_4)_2SO_4$	$Ca(NO_3)_2$	$MgSO_4$	
Magnesium sulfate (Control)	Control	–A	.00025	.00025	.00025	.00125	0.002
		–B	.00025	.00025	.0005	.001	0.002
		–C	.00025	.0005	.00025	.001	0.002

TABLE 5

Comparing the data obtained from all the "best" cultures[a] *(Compiled from the data in large tables, which for lack of space are not published in this paper)*

DATE OF EXPERIMENTS	CULTURE DESIGNATION	SALT PROPORTION	HEIGHT OF TOP	LENGTH OF ROOT	WEIGHT OF DRY TOP AND ROOT	EXTERNAL APPEARANCE OF PLANTS
September 26 to October 17 1926	C–Mg$(NO_3)_2$–3	1 part KH_2PO_4 2 parts $(NH_4)_2SO_4$ 1 part $Ca(NO_3)_2$ 4 parts $Mg(NO_3)_2$	105	105	97	Plants pale green; tips of leaves dried; roots few.
	C–$MgH_4(PO_4)_2.H_2O$–2	1 part KH_2PO_4 2 parts $(NH_4)_3PO_4$ 1 part $Ca(NO_3)_2$ 2 parts $MgH_4(PO_4)_2.H_2O$	94	100	86	Plants stunted; tips of leaves dried; few roots.
	Control	1 part KH_2PO_4 1 part $(NH_4)_2SO_4$ 1 part $Ca(NO_3)_2$ 5 parts $MgSO_4$	100 (62.1 cm.)	100 (26.5 cm.)	100 (0.293 gram)	Plants normally developed.
January 5 to January 26 1926	C–Mg$(NO_3)_2$–3	1 part KH_2PO_4 2 parts $(NH_4)_2SO_4$ 1 part $Ca(NO_3)_2$ 4 parts $Mg(NO_3)_2$	103	102	82	Plants pale green; tips of leaves dried; roots few.
	C–$MgH_4(PO_4)._2H_2O$–2	1 part KH_2PO_4 2 parts $(NH_4)_2SO_4$ 1 part $Ca(NO_3)_2$ 2 parts $MgH_4(PO_4)_2.H_2O$	82	111	73	Plants stunted; tips of leaves dried; roots few.
	Control	1 part KH_2PO_4 1 part $(NH_4)_2SO_4$ 1 part $Ca(NO_3)_2$ 5 parts $MgSO_4$	100 (50.0 cm.)	100 (21.0 cm.)	100 (0.278 gram)	Plants normally developed.

[a] The culture giving the highest yield of dry weight of tops and roots from each trial or set of cultures, is designated as the "best" culture.

TABLE 6

Showing the data[a] as relative values obtained from the best culture in each of the salt series studied

CULTURE NO.	HEIGHT OF TOP			LENGTH OF ROOT			WEIGHT OF DRY TOP AND ROOT			EXTERNAL APPEARANCE OF THE PLANTS
	a[c]	b[d]	Av.	a	b	Av.	a	b	Av.	
B-$(NH_4NO)_3$-4	121	103	112	126	102	114	125	132	128	Plants dark green; vigorous; abundance of roots.
B-$(NH_4H_4(PO_4).H_2O)$-4	110	105	108	124	98	111	107	103	105	Plants fairly developed; normal green; tips of leaves dried.
C-$(Mg(NO_3)_2$-$)_2$-$)$-3	105	110	108	105	114	109	97	82	89	Plants rather slender, culms and leaves pale green.
C-$MgH_4(PO)_4.H_2O)$-2	94	82	88	100	111	106	86	73	79	Plants highly chlorotic.
Control[b] $MgSO_4$ series	100	100	100	100	100	100	100	100	100	Normal.

[a] These data were selected from a mass of data which for lack of space, are not presented here.

[b] Given the value 100; the other *actual values* were reduced relatively.

[c] All data under *c* are for trial 1.

[d] All data under *d* are for trial 2.

EXCHANGE NOTES

It may be interesting to know what an average hen can convert into eggs during the course of a year. There could be no more dependable or authoritative guide in this regard than the average of averages of feed consumption in egg laying contests, determined from the records of six successive years and averaged from every province in the Dominion. These figures show that the average hen will consume 157.4 pounds of feed a year. Of this total 83.6 is grain or meal mixture, and 22.8 per cent green feed. Add to this 41.2 pounds of milk and the feed supply straight from the farm totals 157.6 pounds per bird or over 93 per cent of the feed required. The supplementary feed included 3.3 pounds beef scrap, 1.9 pounds grit, 3.4 pounds shell, and 1.2 pounds charcoal. A flock of 150 hens will convert 8,856 pounds of farm grown feeds into eggs and under ordinary conditions will show 100 per cent profit over cost of feed at current prices which is in itself a valuable item of income for any farm.

—*The Journal of Agriculture and Horticulture* (Canada).

It is, of course, impracticable to send every farmer's boy to an agricultural college. The next best thing then is for all prospective farmers to become members of a Young Farmer's Club. The object of these clubs is to interest children in country life, and to interest boys in various phases of farm work. In some places there are girls' clubs, the object of which is to instruct girls in branches of domestic work.

In many parts of the world the Young Farmers' Club movement has been enthusiastically supported during the past few years. It is said that, in the United States of America, a million children are members of various clubs, the chief of which is known as the 4H Club. Its emblem is a four-leaved clover, and on each leaf is stamped the letter H, the four letters representing Head, Hands, Heart, and Health. The pledge made by members is as follows:—"I pledge my head to clearer thinking, my heart to greater loyalty, my hands to greater service, my health to better living for my country, community, and my club." Camps are held by the Club and, at these, short courses of instruction are given, and teams take part in judging competitions. Fortnightly or monthly meetings are held; at these the first hour or so is given up to the discussion of some agricultural or farming problem; the remainder of the evening is devoted to songs, games, &c. The value of the discussions is that it helps the children in the formation of logical opinions and the clear expression of them. Besides improving agriculture and dairying methods, Clubs have created a bond of good fellowship and so strengthened the social life in those districts where they exist.

The first Young People's Club formed in the United States was a Corn (Maize) Club. Its object was to teach the members how to select good seed and the best way to cultivate the plots. The farmers of the district, seeing the good results obtained by the children, not only purchased seed from them, but imitated their methods.

There are hundreds of Stock Clubs in America, Pig and Poultry Clubs predominating, and there are two reasons for this—pigs and poultry can be kept in smaller areas than can cattle; further, there is a quicker return to be had from them. Breeders' Associations do a great deal to originate and foster the clubs. Breeders of Guernseys and Friesians will start clubs for their respective breeds. In those places where there are Pig Clubs the young boars are sold by the children; where there are Poultry Clubs the cockerels are sold to farmers in the surrounding districts. Here, again, an improvement in stock methods has its beginning in the Young People's Club.

It is pleasant to state that many of these Young Farmers' Clubs have been founded in Australia, particularly in Victoria. Though yet operating only in a small way they have had excellent results . . .

—*The Journal of Agriculture of Victoria, Australia*, (February, 1931).

It has been estimated that the Farmers' Cooperative Creamery at Keosauqua, Iowa, will dry 200,000 pounds of buttermilk powder during the coming year, which will be sold largely to patrons. It is not generally known that dry powdered buttermilk is a splendid poultry feed.

—*The Concentrated Milk Industries*, March, 1931.

It is a wonder to me why those whose farms are of such a size that attending to them is a worth-while business do not decide to live right on the farm. Absentee ownership is quite in vogue in the Philippines and while that was to be expected in by-gone days when transportation facilities were lacking so that the comforts and luxuries that go with living in town were unobtainable, there is not that excuse now. People can have what they want about anywhere now. And think of the open air, the life close to nature, and children growing up learning their lessons direct from the work of God. Why live in town and keep a residence there, less comfortable but more expensive to keep, than one that the farmer has right on the farm. Besides, by living right on the farm, fresh eggs, fresh milk, fresh vegetables, chickens and oh, a thousand other fresh things to keep life humdinging can be kept on hand at the cost of a little trouble. These days, when the roads connect the farms with towns and modern inventions make possible the planting of the comforts of life in the farm homes, why not transfer the home to the farm where there are a thousand and one good things to live on, rather than stay in town and haul the thousand and one good things from the farms to the town residence?

—*The Fortnightly News* (Philipppine Bureau of Plant Industry, October 16, 1930).

COLLEGE AND ALUMNI NOTES

Dr. Irene Dobroscky came to the Campus about the middle of July to do research work on a parasite of an insect destructive to pineapples in Hawaii. Doctor Dobroscky is a representative of the Association of Hawaiian Pineapple Canner's Experiment Station. This Experiment Station is situated on the campus of the University of Hawaii. A large research building is under construction by this station.

Doctor Dobroscky had been in the Philippines about two months before coming to the campus. Her first success in finding the parasite she was seeking was on the College Farm.

Dr. G. O. Ocfemia of the Department of Plant Pathology was in Albay from April 18 to April 25 inclusive. He looked into the coconut-disease situation on the San Miguel Estate of the Agusan Coconut Company, San Miguel Island, Tabaco, Albay, where he was a guest of the company from April 20 to April 23. He visited abacá fields in several other places and also the plantation of the Guinobatan Abacá Experiment Station of the Bureau of Plant Industry at Binogsakan to see if bunchy-top occurs in those places.

Through the efforts of the Department of Agronomy, there have been assembled nearly one hundred and fifty cane varieties, most of which are foreign, in the Plant Breeding Garden of the College of Agriculture. These varieties are being used to straighten up variety names of canes now grown or produced in the Philippines. Each of these varieties is being described from both the purely botanical and agronomical view points. Only a few of these varieties are grown commercially in this country, but the others are preserved for breeding purposes.

A compilation entitled "Terms Used on Hawaiian Plantations" was recently received by the Department of Agronomy, from the Agricultural Department Experiment Station, H. S. P. A. In this compilation are listed words of Hawaiian, Filipino, and Japanese origin, which are commonly used on Hawaiian plantations, together with their English translation.

Cards were received announcing the marriage on June 14, 1931, at Hanover, Indiana, of Miss Margaret C. Wilson, formerly of the Department of English in this College and Mr. Roy C. Bennett, managing editor of the *Manila Daily Bulletin*. Mr. and Mrs. Bennett will be at home in Manila after September 1.

Dr. José B. Juliano of the Plant Physiology Department and Miss Teodora C. Ochoa of Calamba were married July 19, at Calamba Parochial Church.

Mr. Elesio K. Ongsansoy instructor in Agricultural Engineering and Miss Remedios Alfonso of Santa Cruz, Laguna, were married on June 2.

The Los Baños Biological Club met on June 25, 1931, at 7:30 p.m., in the Lecture Hall of the Department of Agricultural Chemistry of the College of Agriculture, Los Baños.

The following papers were read and discussed:

"Study of the respiration of the chico."—By Dr. Leon G. Gonzalez.

"A non-symbiotic nitrogen-fixing organism of genus *Azotobacter* in some Philippine Soils."—By Dr. Dionisio I. Aquino.

"A comparative study of corn, cassava, sweet potatoes and pongapong as feeds for swine."—By Dr. M. Mondoñedo and Mr. Fidel Alonte. (Read by Mr. Fidel Alonte.)

In the competitive examination for the Bailon de la Rama scholarships in sugar technology given on June 3 and 4, 1931, in the College of Agriculture, Mr. Abelardo Bantug and Mr. Flores de Leon Felix obtained the highest grades. These two men will succeed Mr. Julian Gomeri and Mr. Manuel R. Monsalud, as Bailon de la Rama scholars in sugar technology.

Because of illness, Mr. Antonio L. Rocafort, instructor in Agricultural Engineering, is on leave without pay for five months, from May 1 to September 30, 1931. Mr. Santiago Cruz, B.S.M.E., B. S. E.E., is taking Mr. Rocafort's place.

Mr. Manuel R. Monsalud, one of the first two Bailon de la Rama scholars in sugar technology, who was graduated last March, is now connected with the Department of Agronomy of the College of Agriculture as graduate assistant in sugar cane culture.

The following students were recommended for graduation by the Faculty in meeting held on June 8, 1931:

Bachelor of Science in Agriculture:

Pedro P. Erce
Gregorio Quiaoit
Juan D. Atienza, B. Agr. '29
Honorato E. Lumang, B. Agr. '29
Anacleto R. Peliño, B. Agr. '22

Bachelor of Agriculture:

Numeriano Cuevas
Diodati Gochangco
Sergio M. Torres

The office of the College of Agriculture Registrar reports the following on enrollment for first semester:

Total enrollment in the College of Agriculture, first semester, 1931-32:

Freshmen		136
Sophomores		161
Juniors		182
Seniors		124
Special Students		15
Special Graduate Students (Working for Certificate in Agricultural Education)		3
Special Post Graduate Student (Working for Master of Science degree)		1
All College Students		622
Cross Registration from:		
College of Veterinary Science	72	
School of Forestry	2	
U. P. Rural High School	21	
All Cross Registration		95
Total Enrollment		717

Woman students entered the College of Agriculture, first semester, 1931-32	14
New students entered the College of Agriculture, first semester, 1931-32	125

Of these 125 students, 3 are women.

Lower School Education of New Students:

General Secondary:	
Public	84
Private	21
Agricultural High School	17
Trade (High) School	1
Intermediate (special students)	2
Total	125

FREDERICK A. G. MUIR[1]

In a recent issue of the *Journal of the Pan-Pacific Research Institution*, there appear two articles[2] on Dr. Frederick A. G. Muir, entomologist of the Hawaiian Sugar Planters' Association, who died in England on May 13, 1931. To us at the College of Agriculture, the passing of Doctor Muir means more than merely the loss of some great scientist in a remote corner of the globe. It means the loss of a friend and co-worker. For Doctor Muir, during his four years in the Philippines, from 1914 to 1917, in search of beneficial insects for introduction into Hawaii, identified himself closely with the College of Agriculture, and was extremely helpful in many ways. That was at the time when this institution was practically just beginning to emerge from its swaddling clothes and needed the support of men who could appreciate with a sympathetic understanding its many peculiar problems. Even after he left, Doctor Muir maintained a living interest in this College through correspondence with our late Dean Baker. Likewise through his voluminous published contributions, many of which appeared on the pages of the *Philippine Journal of Science*, Doctor Muir greatly enhanced our knowledge of Philippine insects, especially in very difficult groups of Homoptera. He was, indeed, a scientific benefactor to the Philippines, and more so because his work at Los Baños which resulted in the drafting there of *Scolia manilae* Ashmead and the eventual spectacular subjugation by this wasp of the menacing white grub, *Anomala orientalis* Waterh., in Hawaii, has paged the Philippines as a participant in the world-wide triumphant march of man against destructive forces of Nature.

A more direct, but little appreciated, because not so generally known, service he rendered this country was his influence, through his writings and by personal canvassing of the powers that be, in making Mount Maquiling a national botanic garden. Incidentally, this was, so far as we are aware, the first move in that direction in the Philippines. Like the true naturalist that he was, he had a keen appreciation of the usefulness of a sanctuary for all forms of wild life. There is real satisfaction in reflecting that this venerable mountain, whose fame was sung through the centuries by poets, recorded by chroniclers, and its enthralling legends repeated

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[1] General contribution No. 294. Received for publication August 21, 1931.

[2] Pan-Pacific Research Institution. 1931. Dr. Frederick A. G. Muir. Jour. Pan-Pacific. Research Institution 6: (No. 3): 2.

Swezey, O. H., and F. X. Williams. 1931. The work of Dr. Frederick A. G. Muir in the biological control of sugar cane insects in Hawaii. *Ditto:* 2–10.

THE PHILIPPINE AGRICULTURIST, VOL. XX, NO. 5, OCTOBER, 1931.

far and wide to children of Filipino homes, should have this one more laurel added to its name.

The Ibalois, up in Northern Luzon, believe that the souls of all good Igorots find their final resting place on top of their majestic Mount Pulog. We of our region of the Philippines are tempted to copy that beautiful tradition and reserve Mount Maquiling for Doctor Muir, where the wild creatures that he so loved and cherished during life could pay him eternal homage.

The history of Doctor Muir's scientific life comprises some of the most brilliant chapters in the history of biological control of insect pests. Although he was never formally connected with the College of Agriculture or any other Philippine scientific institution, we always regarded him as one of us; and we naturally took justifiable pride in his achievements. We deeply regret his irreparable loss.

L. B. Uichanco
Of the Department of Entomology

(*Message sent by Owen D. Young in behalf of American industry to World Power Conference in session in Berlin, July, 1930.*)

Gentlemen of the World Power Conference: The electrical manufacturers of the United States congratulate you on the interchange of ideas and experience which is taking place in Berlin. Science knows no national boundaries. It jumps frontiers as easily as my voice. Exploration is our most fascinating activity. The application of new discoveries to our needs is our most productive occupation. Just as the greatest wealth of earlier times came from geographical exploration, so the resources of our time are being vastly enlarged by scientific discovery. Voyages into new domains, whether they be in the atom or in the heavens, bring back richer cargoes than the gold and spices of the Indies. These new explorers plant no flags to evidence national dominion. New lands in science are the property of the world. Faraday, Volta, Ohm, Ampere and Edison, are as universally recognized and acclaimed in the field of science as Dante, Montaigne, Goethe and Shakespeare are in the field of literature. All have displayed great constructive imagination. Each was skilled in his art. The scientists multiply the capacity of the human arm by increasing the power at its disposal. The authors amplify the capacity of the human brain by enlarging its horizon and stimulating its action. You who represent the electrical industry everywhere are the trustees of the ideas and achievements of the scientific geniuses of the world. As such it is your duty and your privilege to set them most usefully and most widely at work. Please accept my heartiest congratulations on your great undertaking. I wish you all success.

—*The Review of Reviews*—February, 1931.

A COMPARATIVE STUDY OF ALCOHOL, GASOLINE, AND KEROSENE AS FUELS FOR TRACTOR ENGINES[1]

A. L. TEODORO
Of the Department of Agricultural Engineering

WITH FOUR TEXT FIGURES AND SIX CHARTS

The suitability of alcohol as a fuel for tractor engines is of primary importance in the Philippines because it can be produced in quantities that are more than sufficient to meet the demand. The Philippines offers an abundant supply of raw materials for the manufacture of alcohol. The extensive nipa swamps, the discarded molasses from the sugar mills, and the sawdust from lumber mills are potential sources capable of producing millions and millions of gallons of 95 per cent alcohol annually. There are coconuts, yams, cassavas, bananas, and other fruits which could be grown in unlimited quantities to provide additional sources of supply.

The importation of gasoline, kerosene, and crude oil as fuels for internal combustion engines in the Philippines increases by more than a million gallons a year. The growing number of motor cars, buses, and stationary internal combustion engines calls for more and more fuel practically all of which is being drawn from the resources of other nations. By having a readily available, inexpensive fuel like alcohol, which can be produced locally, the advent of internal combustion engines as a source of power can be accelerated with much economy.

The large sugar centrals in the Philippines began to use motor alcohol as fuel for their tractors in 1922. Attempts were made to run motor buses, trucks, automobiles, and locomotives with alcohol.

A company known as the Philippine Motor Alcohol Corporation was incorporated in 1922 for the purpose of manufacturing motor alcohol and other grades of alcohol from sugar cane molasses. The Foster formula, with the following composition was used: Ethyl alcohol, 55.5 per cent; sulfuric ether, 42 per cent; kerosene, 2 per cent; pyridin, 0.5 per cent. With the use of this fuel, it is claimed that as much mileage as with the best grade of gasoline was obtained and that cold motors could be easily started and more power could be developed than with gasoline. Spark

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[1] Materials for this paper were a portion of the dissertation presented by the author to the faculty of the Graduate School, Cornell University, Ithaca, New York, in partial fulfillment of the requirement for the degree of Doctor of Philosophy. Another portion of the thesis was published in Vol. I, No. 3 of the *Natural and Applied Science Bulletin* of the University of the Philippines under the title "Effect of variable compression ratio in the performance of a tractor engine using alcohol."

Experiment Station contribution No. 742. Received for publication, July 23, 1931.

plug troubles were not in evidence and the amount of lubricating oil necessary was reduced. A modified carburetor was required for the fuel. The change in the carburetor is described as follows:

> Gasoline carburetors have been altered to limit the air that reaches the mixing chamber by fitting into the intake a short copper tube with a metal disk seated within at an angle. The disk is soldered to a cross pin and the opening is regulated by a small coiled spring. As the speed of the motor is increased the suction of the air lifts the disk and more air is admitted as required.

In an article entitled "Use of Alcohol as Fuel in the Philippines Found Steadily Growing from Year to Year" which appeared April 25, 1931, in *The Philippines Herald*, a Manila daily newspaper, the following statement was made:

> In Occidental Negros the use of motor alcohol in autobuses on the provincial roads has become quite extensive. The sugar centrals use it in locomotives, tractors, trucks, and automobiles. The locomotives have engines constructed specially for burning alcohol and get practically the same power and mileage as similar engines burning gasoline. The heavy Caterpillar tractors having high compression engines also get practically the same results per gallon as they do with gasoline. The ordinary gasoline engine used in trucks, autobuses and automobiles show about 75% efficiency per gallon of motor alcohol as compared with gasoline. The lower price of alcohol in Negros more than compensates for this loss of efficiency. The general use of the type of motor alcohol common in the Philippines in automobiles has not been found practicable, on account of the carburetor adjustments found necessary in gasoline engines for its use; but the use of alcohol in gasoline engines has been found highly beneficial, because there is no carbon resulting from combustion of alcohol and because the use of motor alcohol keeps the engine parts bright and clean. Motor engines, after using alcohol fuel for eight years, have been dismantled and cylinders, piston, and other engine parts that come in contact with the alcohol have been found to be bright and smooth and show less wear than these engine parts in automobile engines that have used gasoline.

Motor alcohol fuel of different composition has been tried in Germany, France, England, United States of America, Melbourne University, Poland, Sweden, Porto Rico, Czechoslovakia, Brazil, Australia, Philippine Islands, Cuba, and Costa Rica. Tests were carried on to overcome the technical difficulties that were involved not only in the making of alcohol from various sources but also in making it suitable as fuel for internal combustion engines.

OBJECT OF THE PRESENT WORK

It was the object of this study to compare alcohol, gasoline, and kerosene as fuels in tractor engines. Straight alcohol of different percentages and diluted and undiluted denatured alcohol were used instead of motor alcohol fuels which are of different compositions. No attempt was made to increase the heating value of the fuel by the addition of ether, gasoline, or kerosene.

One hundred and fifty-seven tests were carried on with the following major objects in view.

1. Can tractor engines which are originally designed for kerosene and gasoline be run on alcohol?

2. Without changing the compression ratio, what change or changes are necessary in the carburetion and ignition systems before an engine can be run on alcohol?

3. What is the consumption of each engine at different loads using different kinds of fuel?

4. What are the relative brake thermal efficiencies at different loads?

5. What is the behavior of each engine when run on different fuels with regard to ease of starting, flexibility, smoothness in operation, overheating, pre-ignition, knocking, and corrosion?

TIME AND PLACE OF WORK

All the experiments were made in the Rural Engineering Laboratory of Cornell University, Ithaca, New York, U.S.A., from February 23, 1928 to April 20, 1928.

MATERIALS AND METHODS

Apparatus used in tests

Engines. The engines used comprised two 15-30 McCormick-Deering tractors, one Cletrac "K" tractor, and one Fordson tractor.

McCormick-Deering engine, rated 15-30 h. p. Two McCormick-Deering tractors of this type were employed. One, tractor A, had been used for one complete season on the Cornell University farm. The other, tractor B, was a new tractor having been sent directly from Chicago a few days before the tests were made.

Both tractors were equipped with vertical, four-cylinder, valve-in-head engines. The cylinders and cylinder heads were water cooled. All cylinders were removable. High tension magneto ("E4") and Ensign "RW" carburetor were used. In tractor A, the water bowl was directly under the bowl of the kerosene carburetor. In tractor B, the water bowl was separated. A Pomona "Vortex" oil spray type was used. The engines were each fitted with a centrifugal or flyball type of governor.

Both engines were rated 15-horsepower at drawbar and 30-horsepower on the belt. The engine speed was 900 r.p.m. (reported as 1000 in some publications of the International Harvester Company) and the pulley speed was 595 r.p.m. The bore was 4½ in.; the stroke, 6 in.; and the compression ratio, 4.24 in. each.

Cletrac "K", rated 15-25 h. p. The Cletrac tractor used in the tests was about two years old. It had been used for two complete seasons on the Cornell University farm. The only alterations made on the engine a few weeks before the tests, were valve grinding and cleaning of the carbon in the cylinders and pistons.

The tractor was provided with a vertical, four-cylinder, valve-in-head engine. The cylinders and cylinder heads were water cooled. Cylinders were cast en bloc. The engine was equipped with an Eisemann, "GS4" magneto, Tillotson "R2" carburetor, and a Pomona, oil-fibre type of air cleaner. A flyball type of governor was used.

The engine was rated 15-horsepower at drawbar and 25-horsepower on the belt. The engine speed was 1375 r.p.m.; and the pulley, 860. The bore was 4 in. and the stroke, 5½ in. The compression ratio was not measured.

Fordson tractor, rated 20 h. p. The Fordson tractor used was a new tractor, the breaking in of which took place in the laboratory of the Rural Engineering Department at Cornell University.

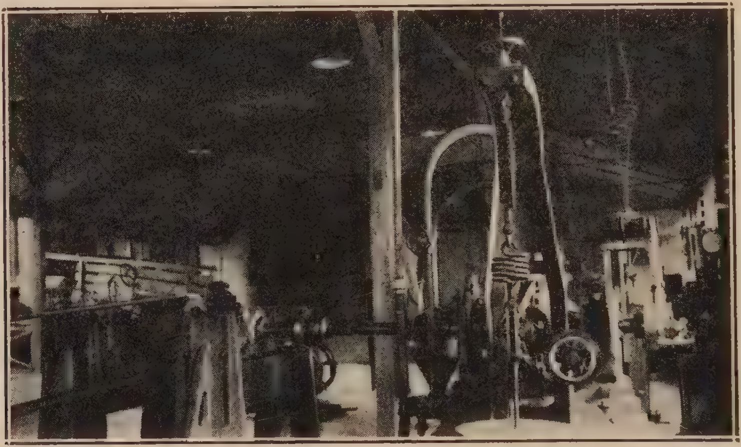

Fig. 1.—A portion of the Rural Engineering Laboratory, Cornell University, showing the Froude dynamometer which was used during the tests.

The tractor was equipped with a vertical, high-compression L-head engine. It used a Fordson magneto, a Holley "235" carburetor, and a water-type air cleaner. There was no governor. Compression ratio was 4.22.

The description of the motor as given by the Ford Motor Company is as follows:

> Four cylinder, four cycle, cylinders cast en bloc. Cylinder bore is four inches; piston stroke, five inches. Piston displacement 251.3 cubic inches; piston clearance: top 0.0150, skirt 0.0045. Valves have 5/16 inch lift. Inlet opens 10° past upper dead center with piston 1/64 inch above top of cylinder; inlet closes 40° past lower dead center with piston 4-1/4 inches to 4-15/32 inches below the cylinder. Exhaust opens 30° ahead of lower dead center with piston 4-11/16 inches to 4-3/4 inches below top of cylinder; exhaust closes on upper dead center with piston 1/16 inch to 5/64 inch above top of cylinder. Tappet clearance is 0.020. Valves are made of special alloy steel.

Cooling was of the thermo-syphon type.

Testing appliances[2]

Dynamometer. The dynamometer used was of the hydraulic type commercially known as the Froude dynamometer. It was manufactured by Heenan and Froude, Worcester, England and distributed in the United States by the C. H. Wheeler Manufacturing Company, of Philadelphia, Pennsylvania.

The dynamometer was of a size D. P.×4 and could absorb a maximum of 150-horsepower at from 1200 to 4000 r.p.m. The brake horsepower is calculated from the following formula:

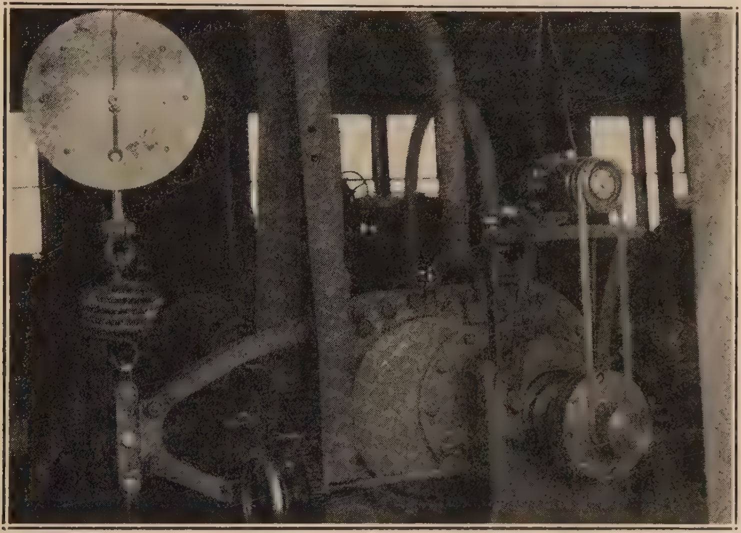

Fig. 2.—A close up view of the Froude dynamometer showing the scale dial and the Weston voltmeter Model 273. The magneto generator was used to measure the speed of the dynamometer.

$$B.H.P. = \frac{WN}{2400}$$

where $B.H.P.$ = Brake horsepower developed

W = Load in pounds read at the end of dynamometer arm

N = r.p.m.

2400 = the numerical constant for the instrument

The load in pounds was read directly on the circular scale dial of the dynamometer, the smallest division of the scale being 0.5 of a pound. The r.p.m. of the shaft was read directly from a Western Electric speed indicator consisting of a magneto and voltmeter calibrated to read in r.p.m. Every reading made was checked up with a tachometer. The readings of both the tachometer and the indicator were accurate within 5 r.p.m.

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[2] Description of "Testing appliances," and "Procedures of tests" were published by the author in an article "Effect of variable compression ratio in the performance of a tractor engine using alcohol," Vol. 1, No. 3, *Natural and Applied Science Bulletin* of the University of the Philippines.

In line with and coupled to the dynamometer's main shaft, through two Spicer universal joints, was another shaft carrying a pulley 12 inches in diameter. This shaft was carried by two Timken roller bearings assembled in self-aligning blocks, made by the Dodge Manufacturing Company. The power was transmitted from the engine to the dynamometer by means of a six-inch, six-ply rubber belt about 100 feet long. Some Dixon's belt dressing compound was applied to the belt to help reduce slippage.

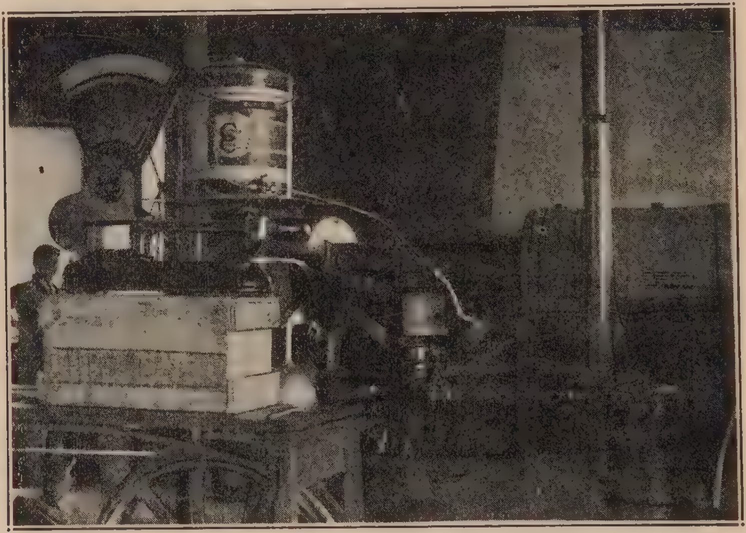

Fig. 3.—Showing the fuel measuring device and portion of the carbureting system. Note the A. P. Bench scale No. 4644. The scale dial is graduated in hundredths of a pound.

The water supply came from the University's water main. The water left the machine at a temperature varying from 80° to about 120°F.

Fuel-weighing device. For weighing the fuel, there was employed a No. 4644-A. P. Bench scale manufactured by the Toledo Scale Company of Toledo, Ohio. These scales were capable of weighing a total of 15 pounds of which 10 pounds were recorded on a beam with sliding poise and 5 pounds on a scale dial graduated in hundredths of a pound, over which there moved a pointer actuated by the scale mechanism.

The fuel tank was mounted on the platform of the scales and connected to the carburetor through a length of copper tubing with a flexible coupling of rubber tubing at each end. The scales were so placed that they could be accurately read and so that sufficient head for the fuel supply was provided, while at the same time, the progress of the test did not produce any variation in the "tare" due to the connection to the carburetor.

Tachometer. For observing the speed of the dynamometer, there was provided a Model 44 Weston magneto connected to a Model 273 Weston voltmeter manufactured by the Weston Electrical Instrument Company of Newark, New Jersey. The magneto-generator was mounted rigidly on a stand above the end of the dynamometer shaft on which was mounted a pulley carrying a 1-inch cotton belt to the magneto pulley with a 1:1 ratio of diameters. The voltage generated by this instrument at different speeds was recorded on the voltmeter of which the scale was divided to read directly in r.p.m. of the generator and so of the dynamometer shaft. Speeds thus indicated were checked by an accurate tachometer held at the end of the dynamometer shaft and were found to be the same within the range of five revolutions value of the individual scale divisions of both the instruments.

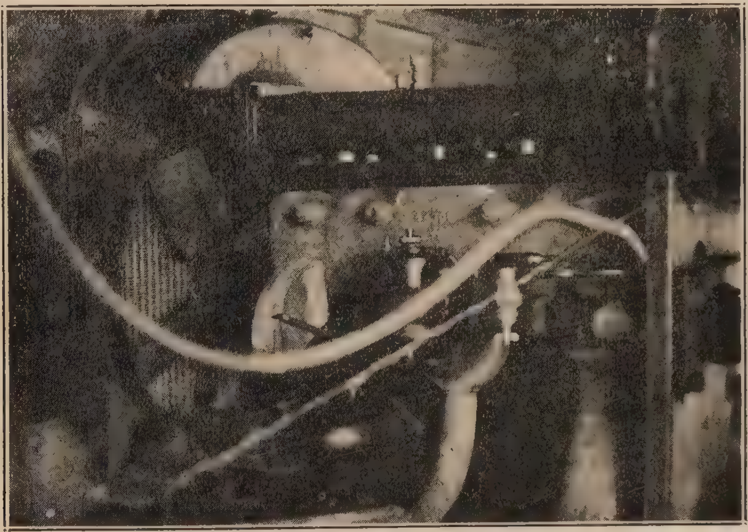

Fig. 4.—Showing the throttle opening measuring device. The rigid pointer arm was firmly attached to the throttle rod so that it could indicate a maximum displacement of 90°.

Time recorder. A stop watch reading to 1/5 of a second was employed for recording the time during the test.

Throttle opening measuring device. A device to measure the throttle openings on one of the McCormick-Deering engines was made. A rigid pointer arm was firmly attached to the throttle rod so that it could indicate a maximum displacement of 90°. The degrees of opening were read on a scale which was firmly bolted to the cylinder block. The graduation on the scale read in degrees and tenths of a degree for a maximum of 90°.

Procedure of tests

Adjustment of engines and testing appliances. Before any tests were started, careful attention was given to lubrication of all bearings of the dynamometer. For each test made, sufficient time was spent to warm up the engine. The carburetor opening was adjusted until a constant running condition which could be maintained was arrived at.

Fuel passage-ways. In all tests with alcohol, except those conducted with the Fordson tractor, fuel passage-ways larger than those provided for gasoline were constructed in the carburetors. Tests were carried on kerosene and on gasoline with the usual carburetor jet or hole provided by the manufacturer. In many instances, however, whenever tests were repeated or checked up, two carburetor holes were used even if the fuels were gasoline or kerosene. Two holes were generally provided in the carburetor for all tests using alcohol. With proper fuel needle-valve adjustment, no bad effect was noted when larger carburetor passage-ways were used for either gasoline or kerosene.

Fuel needle valve. The heads of all the fuel needle valves on the McCormick-Deering tractors were divided into 64 notches. Stationary pointers provided the means of noting exactly how many turns or fraction of a turn constituted a certain adjustment. No readings of fuel needle valve openings were made on either the Fordson or the Cletrac.

It was attempted in all tests to adjust the fuel needle valve so that its opening was the smallest possible to carry the load set for it. There were cases, however, where two to six trial tests were made to note the variation in consumption with variations in the fuel needle valve opening.

Fuel measurement. In measuring the fuel, it was found by experience that a variation in head on the fuel supply of more than the variation which resulted from the drawing of five pounds from the fuel can, resulted in objectionable inaccuracies in the rate of fuel consumption by the engine. Accordingly, only so much fuel as could be measured out within the range of the very accurate chart was used without refilling the container. The process was to add fuel until the scale indicator stood slightly beyond the five-pound mark and then, as it moved back, to catch, with a stop watch, the time for some conveniently observed scale reading and then, at the end of some definite time interval, as three to five minutes, the scale reading was again taken. The construction of the scale diagram and pointer was such that these readings were easily made exact and it was found that they could be readily duplicated within 0.02 pound.

If it were found that in a series of ten readings, four or five of the readings deviated ± 0.02 from the mean, the test was discarded. Some readjustments were made until, with about the same load, a condition that would continue uniformly was attained.

Very often, readings were taken at two-minute intervals for a period of ten minutes to prove the constancy of any run. No regular run was started until operating conditions of satisfactory uniformity were attained.

Ignition points. The degree of advance or of retardation of the point of ignition was indirectly measured by the extent to which the spark lever was advanced or retarded. By calibrating the quadrant over which the spark lever was moved in terms of crank angle degrees, the point of firing for each test was easily determined. In the case of the Fordson tractor where induction coils were used, the range of continuous sparking was recorded.

Injected water measurement. The 15-30 McCormick-Deering tractors were the only ones provided with water-injecting devices. It was found necessary in both gasoline and kerosene tests to use water when the loads applied were at about 75 per cent of the full to normal loads. Before taking any measurement, the water tank of the engine was filled to full capacity. The water needle valve was kept shut until the time came to commence taking fuel consumption data. The actual time which the engine was kept running with a constant load and with the water injected into the intake manifold was recorded. The water needle valve was shut at the end of the test. The tank was then refilled with water and the volume of the water added was recorded.

Results observed and calculated

Observations were made of the temperature of the testing room, of the cooling water, of the wet and dry bulbs of a psychrometer, and occasionally of the discharged water from the dynamometer. All of these temperatures were measured in degrees Fahrenheit by the use of mercury thermometers. All index settings, whether they were adjustment of the carburetor, adjustment of the ignition, adjustment of the throttle, or of the water needle valve, were read directly from their corresponding index dials or scales.

Duration of tests. The duration of the tests included only the actual time that fuel measurements were made. It did not include the time for warming up the engine, pausing for refueling, or the time interval necessary for the engine to attain a constant, steady running condition.

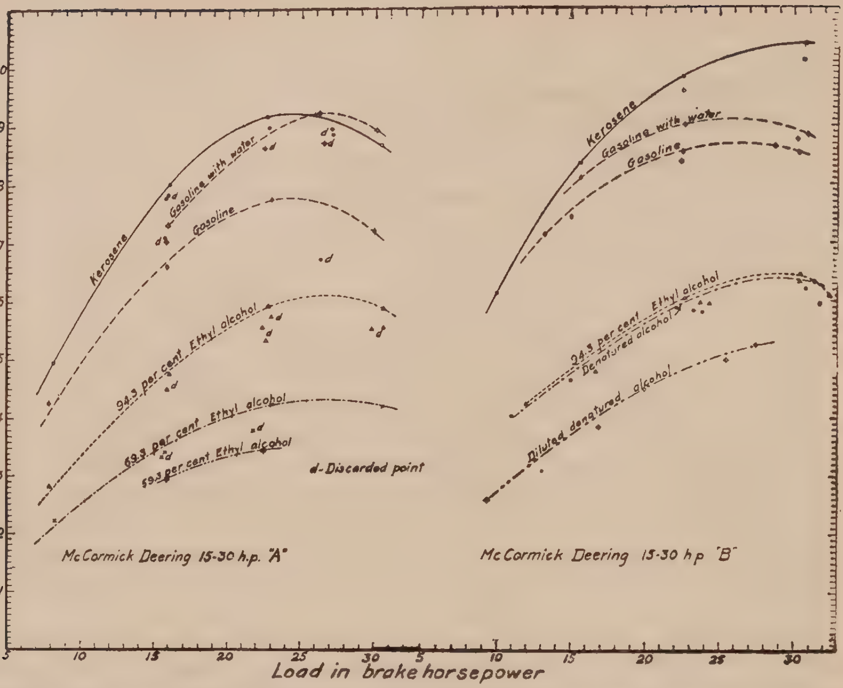

Chart 1.—Showing relation between brake horsepower hours per gallon and load in brake horsepower.

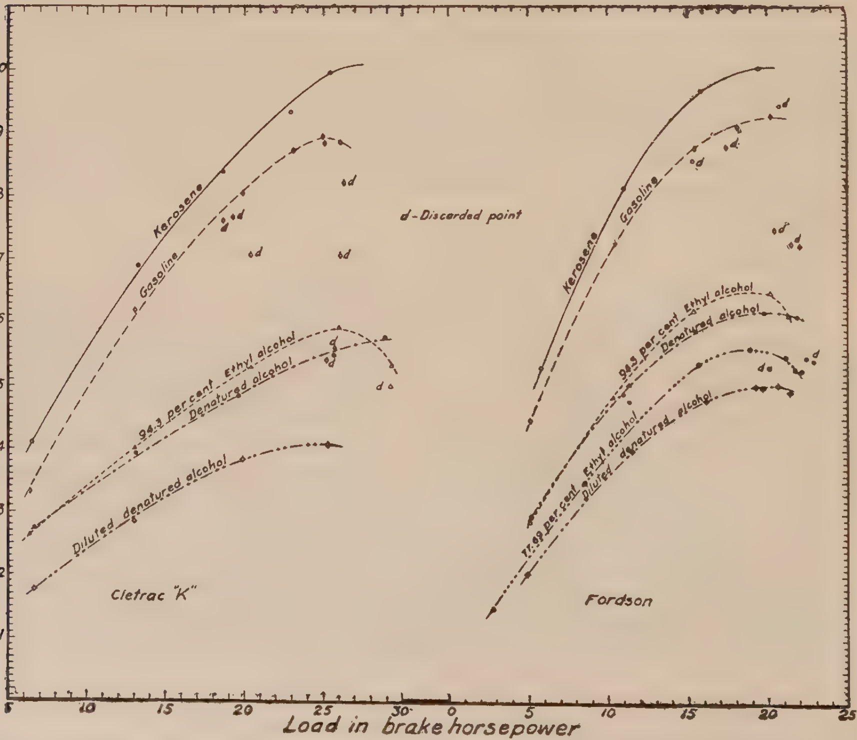

Chart 2.—Showing relation between brake horsepower hours per gallon and load in brake horsepower.

Fuel consumption. The fuel consumption was computed under the headings, pounds per hour, gallons per hour, pounds per brake horsepower hour, and brake horsepower hours per gallon.

Brake thermal efficiencies. The brake thermal efficiencies were computed from the formula:

$$B.T.E. = \frac{2545}{W \times H} \times 100, \text{ where}$$

$B.T.E.$ = Brake thermal efficiency in percentage calculated from measurements given in tests data.

2545 = the heat equivalent of 1 horsepower hour in $B.t.u.$

W = the weight in pounds of the fuel consumed per brake horsepower hour.

H = Heating value in $B.t.u.$ per pound.

In the computation of the brake horsepower delivered and of the brake thermal efficiencies, no correction was made for belt slippage, or for belt efficiency, or for the frictional losses which occurred in the Timken roller bearings which carried the driven pulley shaft. It is therefore unfair to the engines tested to consider the values for these two items as being the actual amount developed. However, since the condition under which the tests were carried on was probably better than the conditions under which these tractors are ordinarily used for belt work on the farm, the values that are presented here may be considered fairly satisfactory.

Fuels used. The different fuels used and the number of tests performed using these fuels in the different tractors are given in table 1.

The composition of the denatured alcohol is given as follows:

100 parts of ethyl alcohol of not less than 160 proof; 4 parts of methyl alcohol; 0.75 part of aldol, grade A; and 0.50 part of approved benzene.

The composition of the other fuels are:

Diluted denatured alcohol.

10 parts by volume of undiluted denatured alcohol added to 2.5 parts by volume of water. The mixture was slightly turbid. Some oily substance was present in the mixture.

Ethyl alcohol, 77.69 per cent by volume.

10 parts of 94.3 per cent ethyl alcohol and 2 parts of water. Clear solution.

Ethyl alcohol, 69.3 per cent by volume.

10 parts of 94.3 per cent ethyl alcohol and 3.58 parts of water. Clear solution.

Ethyl alcohol, 59.29 per cent by volume.

10 parts of 94.3 per cent ethyl alcohol and 6.47 parts of water. Clear solution.

RESULTS AND DISCUSSIONS

McCormick-Deering tractors

Tractor A. Nine groups of tests were carried on in this series. Two carburetor holes were used in all tests in group B, and in 5 tests in group D.

The ignition in all tests was kept fully advanced. This setting is in accordance with the directions of the manufacturer of the tractor which states that the spark lever must be set to the last notch for all running conditions. The full advanced position in these tests measured 43 degrees (crank angle degrees) before the head end dead center. The engine fired at head end dead center in full retarded position.

The results of tests are given in table 2 and in charts 1, 3, and 5.

Ordinarily, when an engine of this type is operated using gasoline instead of kerosene, for which it was designed, users do not think it necessary to open the water needle valve even when the load is nearly normal. For this reason, two sets of tests were conducted to note any difference that may occur with or without the use of injection water.

Tests 3 to 7, inclusive, were carried on without any injected water and with the usual carburetor opening provided by the manufacturer. As is shown in chart 1, a smooth curve is obtained, using as fuel needle valve opening, the smallest that could be adjusted to carry the load recorded in each test. The engine ran smoothly without giving any sign of excessive overheating. Slight knocking was in evidence occasionally near the full load.

The opening of the water needle valve, for just about half a turn, in all the tests in group B, caused a diminution in the consumption per brake horsepower hour. As shown by the curve in chart 3 from about 16-horsepower to beyond 30-horsepower, the drop in consumption reached a maximum of 0.13 of a pound per brake horsepower hour. Tests 29 and 34 show that a difference of 2 notches in the fuel needle valve setting, made a difference of only 0.3 horsepower in the power developed while the difference in consumption was 0.04 pound per brake horsepower hour. Except for a slight difference in the operating temperature, not much change could be noted between the behavior of the engine when run with open water needle valve and with the water needle valve closed.

Only a little over three-quarters load could be carried on by the engine when run on kerosene without water. Even at this load, the radiator temperature was so high that the engine started to knock badly. With the opening of the water needle valve, however, the engine easily delivered 30.3-horsepower. Only slight knocking was evident at this load.

Tests 31, 32, and 33 show how a variation in fuel needle valve opening caused an increase in the fuel consumption with a slight increase in load. With a rich mixture as shown in test 31, the power developed not only went down by about 0.7 horsepower compared with tests 32 and 33, but also raised the consumption per brake horsepower hour by about 0.25 pound. The radiator temperature was also raised. It must be noted that even at this condition, no black smoke was shown by the exhaust.

Tests 13a, 13b, and 13c, again showed how a wrong fuel needle valve adjustment may cause an unnecessary increase in consumption without appreciably changing the load developed. The reason for discarding points marked "d" in chart 1, is justified as wrong fuel needle valve adjustment was used. The engine did not stop running owing to the mixture being over rich.

The air choke had to be closed about half in tests 20 and 21 for the reason that not enough fuel could get into the cylinder. The diameter of the fuel passage-way in the carburetor was 0.095 inch. Fairly good results were obtained up to half the normal load. When two holes were used, giving a much larger passage area, the maximum power developed was raised and the fuel consumption diminished. At least five tests were discarded in groups E and F, for the reason that the fuel needle valve adjustments were not the smallest that could be had to give the horsepower developed.

When the percentage of pure alcohol present in the fuel is diminished, the question of enlarging the fuel passage area becomes of greater importance. Test 25 shows that the maximum power that could be developed using a single hole, having a diameter of 0.095 inch, is only 21.7-horsepower, with the air choke half closed. With two holes, however, the engine developed 30.5-horsepower with the air choke wide open. It was impossible to develop 15-horsepower, using 59.29 per cent ethyl alcohol.

The fuel consumptions of this type of tractor under 100, 75, 50, and 25 per cent of the normal load are given in table 6.

The most economical point using gasoline without water is at about 24-horsepower or 80 per cent of the normal load. With water, the point is moved to about 26.5-horsepower or 88 per cent of the normal load. Using kerosene, the point is also at about 80 per cent of the normal load. The minimum value obtained for gasoline consumption is 0.65, and for kerosene, 0.72 pound per brake horsepower hour.

The equivalent amounts of fuel used in terms of the consumption at normal load are shown in table 7.

It is seen from the table and from the curve that the most economical points when using alcohol are at about 88 per cent of the normal load. At three-quarters load, almost as much fuel as was used for normal load is required when employing alcohol fuels. The ratio varies from 1.31 to 1.79 at half load, being larger for the fuel having the larger percentage of water. At quarter load, the ratio is more than 2 to 1.

The equivalent amounts of fuel used in terms of gasoline, in all loads, is shown in table 8.

Alcohol shows to the best advantage with a minimum consumption of 1.5 times the gasoline consumption for the same load.

The relative brake thermal efficiencies for the different loads are given in table 9.

In general, the brake thermal efficiencies obtained for alcohol fuels are equal to or higher than those obtained for either kerosene or gasoline, at all loads.

The maximum amount of water injected into the cylinder using gasoline varied from about 0.18 gallon per brake horsepower hour at full load to about 0.08 gallon at half load. For kerosene, only about 0.05 gallon per brake horsepower hour, was the average amount used at about 85 per cent of the load.

Starting with alcohol was impossible when the engine was cold. Priming with gasoline made starting possible.

Tractor B. Thirty-seven tests were performed under this series. Double carburetor holes, each having a diameter of 0.075 inch were used in all tests using alcohol.

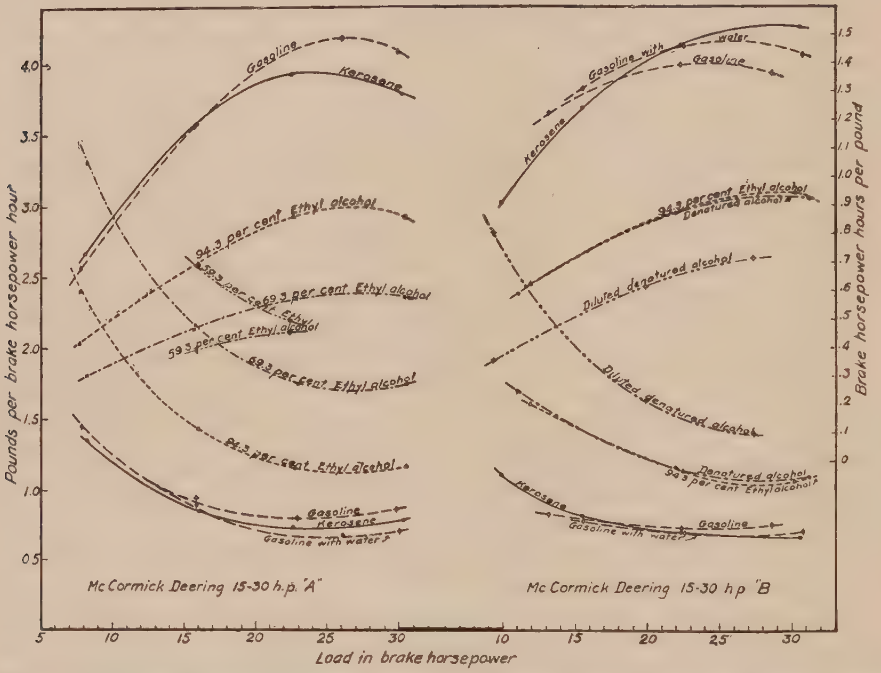

Chart 3.—Showing relation between pounds per brake horsepower hour, brake horsepower hours per pound, and load in brake horsepower.

The results of test are given in table 3 and in charts 1, 3, and 5.

All tests in group A were run with the ignition point advanced 43° before head end dead center. The maximum power that could be developed without the injection water was only 28.7-horsepower. The operation at this load was characterized by some occasional knocking. Even if the spark lever were retarded a few degrees, the amount of consumption did not materially change as shown by short tests.

When water injection was used in group B, the immediate change noticed was the ability of the engine to carry more load. The maximum power that was developed without causing any overheating or knocking was only 30.9-horsepower. Further attempt to increase the fuel needle valve opening resulted only in raising the consumption excessively without any change in power. As shown by tests 200, 201 and 202, with the fuel needle valve opening set to the smallest magnitude capable of delivering enough fuel to carry a little over 30.0-horsepower, variation in consumption could be obtained by varying the ignition point a few degrees. Only one point in group A was discarded (test 197) for wrong needle valve adjustment. Tests 200 and 201 in group B were discarded for the reason that the ignition points were a little too late. No attempt was made in any of the tests to measure the amount of water injected. The water needle valve was open about three-quarters of a turn.

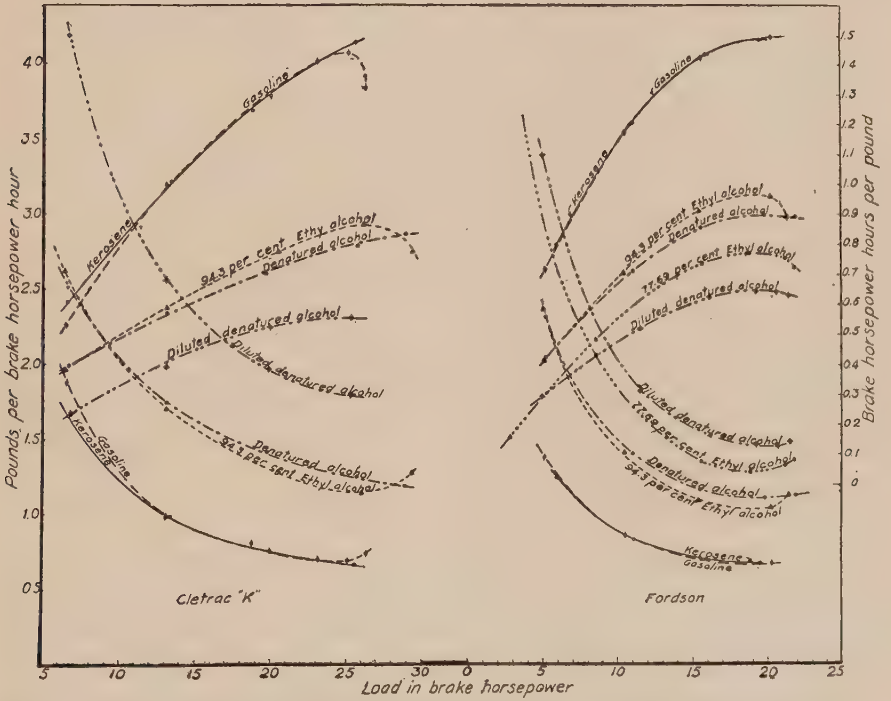

Chart 4.—Showing relation between pounds per brake horsepower hour, brake horsepower hours per pound, and load in brake horsepower.

It is proved in group C, that with wrong fuel needle valve adjustment, the consumption may be varied without any appreciable change in the power delivered. No attempt was made to measure the amount of water injected into the cylinder. The water needle valve was open about a half turn. The points of ignition recorded were the ones giving the engine the best running condition as far as constancy of operation and constancy of sound are concerned.

Attempts to run short tests with varying fuel needle valve openings and ignition timing, failed to improve the results in tests 216 and 218. As shown in chart 1, the smooth line was drawn to pass through the points that gave the best results only.

The maximum power that could be developed by the engine was increased with the use of undiluted denatured alcohol. A number of tests had to be discarded in group E, for the reason that the fuel needle valve openings were not the smallest that could be adjusted to give the power developed.

In group F, 32.3-horsepower was developed without the engine showing any sign of being overloaded. A number of points had to be discarded for wrong fuel needle valve adjustment.

All the tests using alcohol were characterized by very smooth running, constancy of operation, ability to continue the load for a long time, and absence of any trace of pre-ignition or knocking. Not a case of hammering was noted. In general, the engine ran much better using alcohol fuels than when gasoline or kerosene was used.

Some trials were successful in starting the engine when the room temperature was a little over 70°F. As soon as the engine was warmed up, starting with alcohol was a sure thing. A few drops of gasoline through the priming cup, started the engine in one complete turn of the crank, even if the engine temperature was below 60°F. There were cases when the engine started cold, after it had been "choked" several times, and given a full air opening just before cranking.

The consumption of fuel in pounds per brake horsepower hour is given in table 6.

As shown in chart 3, the injection of water to the carburetor had not only reduced the consumption of fuel by weight, by about 4 per cent below the consumption without water, but also increased the maximum power that could be developed. The most economical point for gasoline with water was at about 87 per cent of the normal load; for kerosene at about the normal load; for undiluted denatured alcohol, at the maximum load that could possibly be developed using this fuel; and for the undiluted ethyl alcohol, at 95 per cent of the normal load. The most economical consumption per b.h.p. hour for gasoline was 0.67 pound; for kerosene, 0.65 pound; for undiluted denatured alcohol, 1.06 pounds; for diluted denatured alcohol, 1.39 pounds; and for undiluted ethyl alcohol, 1.02 pounds.

The equivalent amounts of fuel used in terms of the consumption at normal load are given in table 7.

In the case of alcohol fuels, it is seen that approximately 6 to 9 per cent more fuel than the normal is necessary per brake horsepower hour, at 75 per cent of the normal load; and around 37 to 39 per cent more to run it on 50 per cent of the normal.

The equivalent amounts of fuel in terms of gasoline are given in table 8.

The engine undoubtedly operated more economically on kerosene than on gasoline. With the use of alcohol, the smallest ratio in consumption obtained between alcohol and gasoline per brake horsepower hour is 1.39 for undiluted ethyl alcohol and 1. 41 for the undiluted denatured alcohol.

The brake thermal efficiencies, based on high heating values, for loads 100, 75, and 50 per cent of the normal are given in table 9.

The brake thermal efficiencies are generally higher for alcohol fuels than for either gasoline or kerosene.

Drawbar test. A test lasting about 3½ hours was conducted on May 11, 1928, to note how the engine would respond to variability of drawbar pull. The new 15-30 McCormick-Deering was used with undiluted denatured alcohol as fuel. Two carburetor fuel passages were provided each having a diameter of about 0.075 inch. A rolling field of about 15 acres in area was used. On one side of the field, the grade was as high as 15 per cent. A twelve-foot spring-tooth harrow provided the resistance pulled. The field was a part of the Cornell University farm.

Prior to test, the engine was left over-night in the open air with the alcohol fuel already in the tank. In the morning the temperature was about 55°F.

An attempt was made to start the tractor on alcohol at the temperature given above. The engine did not fire once even after several efforts of cranking. One complete turn of the crank was necessary to start the engine when gasoline was squirted through the two priming cocks provided in the intake manifold.

The result of the harrowing test as described above showed that with proper but unvaried needle valve adjustment, the tractor maintained a constancy of pull and moved the load satisfactorily for a period of nearly three hours. No evidence of over-heating, knocking, or pre-ignition was observed during the whole period, and the engine responded readily to the demands resulting from changes in throttle opening.

Cletrac tractor

Cletrac "K". Thirty-three tests were conducted under this series. The carburetor jet was enlarged to about twice as big as the original size before the tests on alcohol fuels were started.

The results of tests are given in table 4 and in charts 2, 4, and 6.

The tractor was not provided with a lever to regulate the time of ignition. The speed of the engine was regulated by a hand throttle lever which slides on notches.

The engine fuel supply system was provided with two exhaust heating attachments, one for gasoline, and the other for low grade fuels. The exhaust was connected to the lower exhaust pipe for both kerosene and alcohol. The upper exhaust pipe was used for gasoline.

The engine had a very efficient water cooling system. At no time in the tests was the temperature of the cooling water found to be above 175°F.

With this type of tractor it was very easy to make a wrong adjustment in the carburetor. Three complete tests were conducted in group A at a little over 25-horsepower load, to show that with a difference of less than 0.15 horsepower, the consumption could be varied from 0.69 pound per brake horsepower hour to 1.15 pounds with improper adjustment of the fuel needle valve.

The maximum power that could be developed was only 26.55-horsepower, using gasoline. Any further attempt to increase the load resulted only in increased consumption of the fuel without any increase in power.

In group B, where kerosene was used, it was found that in developing 25.49-horsepower and 26.14-horsepower the consumption increased from about 0.66 pound to 0.96 pound per brake horsepower hour. Overloading was possible at the expense of too much fuel.

With the use of undiluted denatured alcohol, it was observed that the maximum power developed was 28.9-horsepower. This was an increase of more than 2-horsepower over the maximum that could be developed when either gasoline or kerosene was used. The operation under this fuel was characterized by the absence of knocking, pre-ignition, hammering, and with smooth, steady running.

The maximum power that could be reached using diluted denatured alcohol was 25.33-horsepower. Further attempt to increase the load resulted in increasing the fuel consumption without any change in the power developed.

In group E, where undiluted ethyl alcohol was used, the maximum power developed was 29.38-horsepower. The engine was able to carry this load steadily and continuously for a long period. As seen in chart 2, only two tests were discarded for improper carburetor setting.

Operation with alcohol fuels was satisfactory. The ability to develop a maximum power of about 17 per cent greater than what could be developed using gasoline or kerosene, is one of the factors worth considering in this type of tractor.

An examination of the fuel consumption in chart 4, shows that from about half load to normal, the consumption of fuel in pounds per brake horsepower hour was practically the same for both gasoline and kerosene. Below 50 per cent load, kerosene was more economical than gasoline. The most economical point for gasoline was at about 97 per cent of the normal load, giving about 0.7 pound per brake horsepower hour. For kerosene, this point is at about 102 per cent of the normal, giving 0. 67 pound per hour.

With undiluted denatured alcohol, the point of minimum consumption coincides with the maximum power developed, while with undiluted ethyl alcohol, the point is at 104 per cent of the normal load. The lowest rate of fuel consumption attained for undiluted denatured alcohol is 1.2; for undiluted ethyl alcohol, 1.16; and for diluted denatured alcohol, 1.8 pounds per brake horsepower hour.

The consumption of fuel in pounds per brake horsepower hour at different loads is shown in table 6.

The equivalent amounts of fuel used in terms of the consumption at normal load are given in table 7.

It may be seen from table 7 that the amount of fuel necessary per brake horsepower hour at different loads was approximately 113 to 118 per cent at three-quarters load, 142 to 158 per cent at half load, and 204 to 286 per cent at quarter load.

The equivalent amounts of fuel in terms of gasoline are given in table 8.

It was observed in this type of engine, that the equivalent amounts of fuel used in terms of gasoline decreased from normal load to quarter load, in all fuels used. The ratio between ethyl alcohol and gasoline at 100 per cent load was 1.54:1 while at three-quarters load, it was 1.57:1 (by volume).

The brake thermal efficiencies at different loads for the different fuels used are given in table 9.

The thermal efficiencies obtained are nearly the same for each load for each fuel used.

Fordson tractor

Forty-four experiments were conducted in this series of tests. No change was made in any part of the engine. The carburetor jet was not enlarged. More than 20 hours were spent "breaking in" the engine in the Rural Engineering Laboratory at Cornell University.

The results of tests are given in table 5, and in charts 2, 4, and 6.

Since there was no automatic governor, the motor's speed was controlled by a hand throttle lever. With careless manipulation it was easily possible to race the engine. There were times when the dynamometer load and fuel consumption changed markedly while the engine was in operation because the throttle lever would not stay in place. No record of the fuel needle valve opening or of the throttle openings was taken.

Of the nine tests (Nos. 152 to 160, inclusive) performed in group A, 4 were discarded because of excessive consumption due to improper needle valve adjustment. Another cause which might be responsible for increased consumption was the time of ignition. As shown by tests 152, 155, 156, and 157 when the time of ignition was kept constant and the fuel needle valve adjustment varied, differences in consumption were obtained. When the ignition point was retarded from 50° to 43° and the fuel needle valve opening reduced slightly, the power developed was reduced to the rated load and the consumption greatly diminished.

At about 10-horsepower load, the throttle hand lever was pulled only slightly from its position giving the minimum opening. Occasional knocking was in evidence throughout the full load and the overload tests. The knocking was greatly reduced when the spark lever was retarded.

The best performance of the engine using kerosene (group B) was shown when the power delivered was 19.49-horsepower. Attempts to increase the load beyond this point increased the consumption with very little change in the power developed. As shown by test 162, overloading was done at the expense of too much fuel. Test 163 was discarded for the reason that the ignition point was too much retarded. Nearly all tests approaching the full load were characterized by slight knocking. If some device were provided to inject water into the cylinder at the time the load is nearly normal, greater volumetric efficiency could be obtained. With such an attachment the power could be further increased and the consumption of fuel diminished.

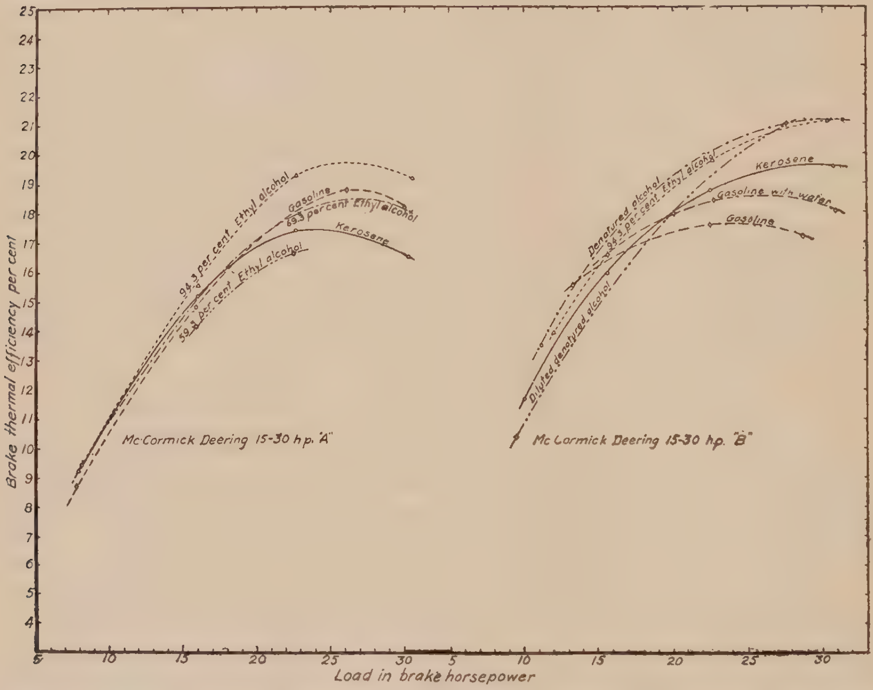

Chart 5.—Showing relation between brake thermal efficiency and load in brake horsepower.

When 94.3 per cent ethyl alcohol was used (group C), the most striking thing observed was the absence of knocking. The motor not only sounded better and operated more uniformly, but also developed a fair maximum load. There was no evidence of any pre-ignition or hammering. At times when the mixture was a little too lean, the transmission belt jerked slightly. A number of short tests showed that retarding the time of spark resulted in uneven operation and a very slight change in consumption.

In group D, where 77.69 per cent ethyl alcohol, was used, it was observed that the maximum power that could be developed did not materially change. Tests 189, 190, and 191 were made to show the variation in fuel consumption with only slight changes in the horsepower developed. Beyond the full load capacity it was easily possible to increase the consumption of fuel by improper needle valve adjustment without any black smoke being noticed in the exhaust.

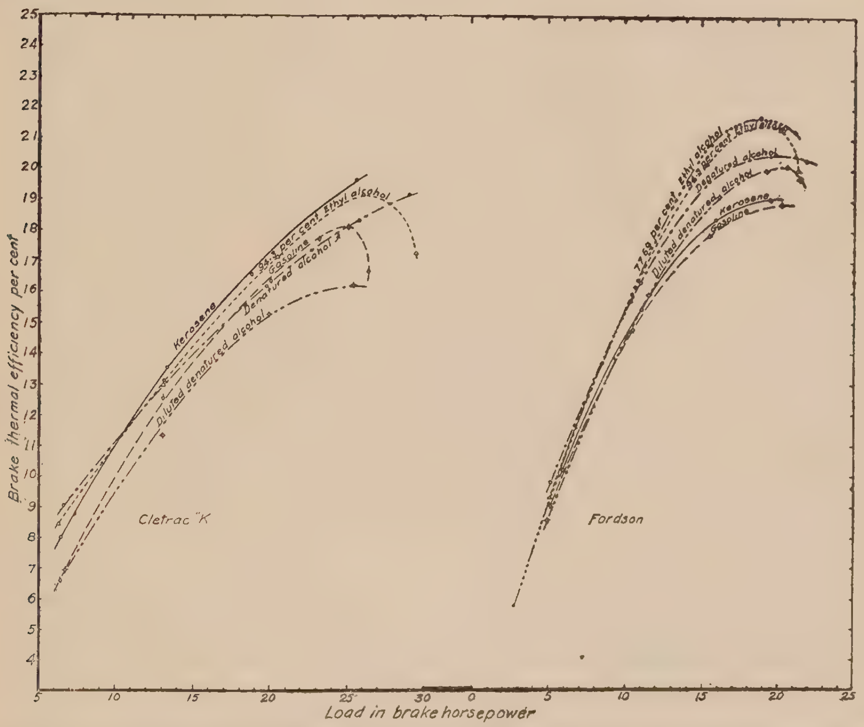

Chart 6.—Showing relation between brake thermal efficiency and load in brake horsepower.

When undiluted denatured alcohol was used, as shown by nine complete runs and a number of short runs, in group E, the maximum power that could be developed was raised to almost 23-horsepower. Not only was the motor capable of operating constantly at this load but also was able to maintain the operation for a long period. At least during the length of time the test was conducted with the maximum load, no evidence of diminution of power was noticed. The engine ran smoothly without knocking, pounding, hammering, pre-igniting or over-heating.

Increasing the percentage of water mixed with denatured alcohol, did not make any big difference in the amount of maximum power developed, nor in the operating characteristics. As shown by the tests in group F, not only was the engine able to develop 21.42-horsepower but also ran at slightly lower radiator temperature. The engine was slightly more noisy than when undiluted denatured alcohol was used.

The consumption of fuel in pounds per brake horsepower hour was nearly the same for both gasoline and kerosene. In both cases the most economical point was at full load. The lowest value obtained for gasoline, taken from the curves in chart 4, is 0.66 pound per brake horsepower hour, and for kerosene, 0.67 pound.

The consumption curve for undiluted ethyl alcohol shows that its most economical point is around 96 per cent of the full load giving a value equal to 1.04 pounds per brake horsepower hour. Undiluted denatured alcohol gave for its most economical consumption 1.11 pounds, appearing at full load. The most economical consumption for 77.69 per cent ethyl alcohol was 1.28 pounds, occurring at about 95 per cent of the normal load; and for diluted denatured alcohol, 1.46 pounds, occurring at full load. The rate of consumption of fuel in all cases increased as the load decreased.

The consumptions of fuel in pounds per brake horsepower hour at different loads are given in table 6. The equivalent amounts of fuel in terms of the consumption at the normal load are shown in table 7.

This table clearly shows that with all the fuels used, at least 6 per cent more fuel per brake horsepower hour than what is required to run the engine at normal load is necessary to run the engine at three-quarters load; at half load, the amount of fuel necessary is approximately from 1.31 to 1.42 as much; and at quarter load, 1.88 to 2.33 as much.

The equivalent amounts of fuel used in terms of gasoline at different loads for each are given in table 8.

The minimum equivalent amount of alcohol used in terms of gasoline is 1.42 by volume, and 1.57 by weight at full load; 1.43 by volume and 1.58 by weight at three-quarters load; 1.46 by volume and 1.61 by weight at half load; and 1.34 by volume and 1.49 by weight, at quarter load.

The relative brake thermal efficiencies obtained for the different fuels at the different loads are given in table 9.

The brake thermal efficiencies are, in general, higher on tests using alcohol fuels than on those using either gasoline or kerosene at all loads.

CONCLUSIONS

1. Water injection was found beneficial in tractors A and B of the McCormick-Deering type when either gasoline or kerosene was used. The consumption was very much reduced from beginning half load to as high as the engine could develop. Injection of water increased the volumetric efficiency and lowered the radiator temperature at these loads. The maximum power developed was increased and knocking due to over-

heating of the engine was minimized. More injection water was consumed per brake horsepower hour when using gasoline than when using kerosene.

The use of injection water may be recommended for Cletrac "K" and Fordson from about half load to normal capacity using gasoline and kerosene.

2. Experiments proved that tractor engines originally designed to run with gasoline and with kerosene could also be run with straight alcohol of different strengths and with diluted and undiluted denatured alcohol.

3. With the exception of the Fordson tractor, enlargement of the carburetor jet was found necessary in all tests using alcohol to admit enough fuel to carry the load. This extra fuel was needed because the compression ratio was not increased and no additional substance was added to alcohol to increase its heating value. The Fordson tractor was a high compression type.

Some tests showed that at or near the maximum load, the ignition points were retarded a few degrees from the maximum position to get the best running condition and most economical consumption. The point of ignition at which the best tests was made on a certain load was a little earlier for alcohol fuels than for either gasoline or kerosene.

4. The consumption of fuel per brake horsepower hour is greater for alcohol fuels than for either gasoline or kerosene. The higher the percentage of alcohol the less is the consumption per given load. The equivalent amounts of fuels used in terms of gasoline are summarized in table 10. The most economical consumptions are given in table 11.

The most economical points for gasoline and kerosene are between three-quarters load and the full normal capacity. For alcohol fuels the points are at the normal load or at the point where the maximum power is developed.

In general, the consumption of fuel in pounds per brake horsepower hour is greater as the load decreases from the normal rating. (Exceptions are those cases where the point of minimum consumption does not fall on the normal load.) A difference of consumption is noted between a new and an old engine of the same type. The difference in consumption between the new and the old 15-30 McCormick-Deering tractor varies from about 17 per cent at half load to 28 per cent at full load. The Cletrac tractor is the only tractor where the equivalent amount of alcohol in terms of gasoline, decreases as the load increases. The maximum brake horsepower hours developed per gallon of fuel are given in table 12. The maximum power that can be developed using alcohol is materially higher than that which can be developed using either gasoline or kerosene.

5. The relative brake thermal efficiencies are generally higher for alcohol fuels than for either gasoline or kerosene.

6. It is easily possible in all the fuels used to have the consumption considerably increased by improper setting of the fuel needle valve. The

chance for getting wrong adjustment is greater in the case of alcohol than for gasoline. This may be due to the fact that the range of explosive mixtures with the former is greater than with the latter.

7. Difficulties may be met with in starting the engine when the motor temperature is below 70°F. Starting could be easily done by priming the engine with gasoline. Operation with alcohol fuel in these types of engines is characterized by smooth running, steady pull, and absence of over-heating, pre-ignition, knocking, or violent hammering. No sign of corrosion was noted.

8. Ample provision to atomize, distribute uniformly, and vaporize the incoming fresh charge of alcohol should be given. External heating of alcohol alone before it is mixed with air may prove beneficial. Overheating of the fresh mixture in the induction pipe may result in a decrease of volumetric efficiency.

TABLE 1

Showing number of tests carried on

TRACTOR	GASOLINE	KEROSENE	ALCOHOL						TOTAL
			Denatured		Ethyl				
					Percentage by volume				
			Pure	Diluted	94.3	77.69	69.3	59.29	
McCormick-Deering 15-30 H. P.									
Engine A	11	12	0	0	11	0	7	2	43
Engine B	10	6	8	5	8	0	0	0	37
Cletrac "K".....	11	6	5	4	7	0	0	0	33
Fordson.........	9	6	9	7	6	7	0	0	44
Total	41	30	22	16	32	7	7	2	157
Sp. gr.	0.744	0.808	.824	0.877	.818	.0870	.892	0.915	

TABLE 2

Results of tests using McCormick-Deering tractor A

TEST NO.	HORSE POWER AS MEASURED BY BELT	AVERAGE ENGINE SPEED	THROTTLE OPENINGS	DURATION OF TESTS	INJECTED WATER	FUEL NEEDLE VALVE SETTINGS	FUEL CONSUMPTION				TEMPERATURE		BRAKE THERMAL EFFICIENCIES BASED ON HIGH HEATING VALUES	BAROMETRIC READINGS
											Cooling water	Room		
	b.h.p.	r.p.m.	degrees	minutes	gal. per hour	notches	lb. per hr.	gal. per hr.	lb. per b.h.p hr.	b.h.p. hr. per gal.	degrees Fahr.	degrees Fahr.	per cent	inches of mercury
A						Gasoline	Sp. gr.=0.744							
7	29.8	1061	70.7	60	0.00	1–52/64	25.53	4.12	0.86	7.23	208.5	66.5	14.8	30.19
6	22.9	1100	47.1	60	0.00	1–49/64	18.28	2.95	0.80	7.77	208.0	66.5	15.8	30.19
5	15.8	1120	39.4	60	0.00	1–43/64	14.81	2.39	0.94	6.61	207.0	69.5	13.5	30.05
4	7.8	1150	34.0	30	0.00	1–37/64	11.34	1.83	1.45	4.28	206.0	72.5	8.7	30.05
3	1.1	1185	30.0	60	0.00	1–32/64	8.54	1.38	7.63	0.81	205.0	72.6	1.7	30.05
B														
27	30.0	1060	66.6	40	5.41	1	20.80	3.35	0.69	8.96	208.0	74.5	18.2	30.31
29	26.4	1100	51.8	30	3.76	63/64	18.74	3.02	0.71	8.74	208.0	83.0	17.9	30.33
34	26.1	1090	53.1	30	3.86	61/64	17.56	2.83	0.67	9.25	208.0	78.5	18.8	30.04
28	22.4	1100	46.2	30	2.22	63/64	16.16	2.61	0.72	8.61	208.0	82.5	17.5	30.33
30	15.8	1120	36.6	30	0.79	63/64	13.86	2.23	0.88	7.05	207.5	77.0	14.3	30.31
35	15.9	1100	41.4	30	1.26	61/64	13.46	2.17	0.85	7.31	207.0	78.5	14.9	30.04
C						Kerosene	Sp. gr. = 0.808							
11	22.8	1100	47.8	60	0.00	1–28/64	17.04	2.53	0.75	9.00	209.5	74.0	17.1	29.83
10	15.8	1120	40.7	60	0.00	1–28/64	13.66	2.03	0.87	7.79	207.0	73.5	14.8	29.83
9	8.2	1160	34.3	60	0.00	1–28/64	11.10	1.65	1.36	4.95	206.0	73.5	9.4	29.82
8	1.1	1180	29.5	60	0.00	1–28/64	9.00	1.34	8.11	0.83	206.4	74.5	1.6	29.82
D														
12	30.3	1069	62.4	60	1.25	1–42/64	23.48	3.48	0.77	8.70	208.0	73.2	16.5	29.60
32	27.1	1100	49.8	30	2.74	63/64	20.54	3.05	0.76	8.88	207.0	78.5	16.7	30.03
33	27.0	1108	49.9	30	2.70	60/64	20.28	3.01	0.75	9.00	207.0	78.5	17.1	30.03
32	26.3	1100	48.5	30	3.03	1–16/64	26.36	3.91	1.00	6.73	208.0	77.0	12.8	30.31
14	22.6	1106	51.0	30	1.02	1–28/64	16.58	2.46	0.73	9.20	206.5	65.6	17.5	30.30
13a	15.8	1120	40.8	30	0.42	1–28/64	13.60	2.02	0.86	7.85	206.0	70.0	14.9	30.20
13b	15.7	1130	34.5	30	0.58	1–42/63	14.84	2.20	0.95	7.12	206.0	70.5	13.5	30.20
13c	16.0	1106	50.2	30	0.30	1–16/64	13.44	1.99	0.84	8.04	206.0	70.5	15.3	30.20
E						Ethyl alcohol	94.3 per cent.	Sp. gr. = 0.818						
21	29.7	1078	60.2	60	ignition[a]	2–39/64	36.53	5.36	1.23	5.54	208.5	73.0	18.1	30.49
15	22.8	1092	59.4	36		2	27.08	3.97	1.19	5.75	206.0	76.0	18.8	30.00
20	22.3	1100	48.7	54		2–39/64	24.02	3.52	1.23	5.56	208.5	74.5	18.1	30.53
16	16.1	1130	39.7	36		1–56/64	22.96	3.36	1.43	4.77	206.0	76.0	15.6	30.01
19	15.8	1140	34.8	60		1–50/64	24.02	3.52	1.52	4.50	208.0	73.0	14.6	30.51
18	7.9	1169	29.1	36		1–40/64	18.98	2.78	2.41	2.84	206.0	69.0	9.2	30.48
17	1.3	1190	26.2	30		1–40/64	14.60	2.14	11.68	0.58	204.0	67.5	1.9	30.47
F														
43	30.5	1051	70.5	30	ignition[a]	1–12/64	35.38	5.18	1.16	5.89	210.0	85.0	19.2	30.14
42	30.4	1048	72.1	30		1–16/64	37.34	5.48	1.23	5.56	209.0	85.0	18.1	30.14
41b	22.7	1150	48.4	30		1–21/64	26.10	3.83	1.51	5.92	209.0	85.0	19.3	30.13
41a	22.5	1150	44.5	30		1–24/64	28.70	4.22	1.28	5.34	209.0	85.0	17.4	30.13
G						Ethyl alcohol	69.3 per cent.	Sp. gr. = 0.892						
25	21.7	1078	60.3	30	ignition[a]	3–16/64	42.28	5.68	1.95	3.82	205.0	66.5	16.3	29.80
24	15.5	1130	38.9	30		3–16/64	34.22	4.61	2.22	3.37	205.0	67.0	14.3	29.84
23	8.2	1140	32.5	45		2–16/64	27.38	3.68	3.23	2.24	204.0	63.2	9.5	29.90
22	1.1	1185	27.5	30		2–16/64	22.52	3.03	20.26	0.37	202.0	61.5	1.6	30.03
H														
38	30.5	1054	66.6	30	ignition[a]	1–16/64	53.46	7.19	1.75	4.24	207.5	80.0	18.1	30.11
37	22.9	1110	44.7	30		1	40.16	5.40	1.75	4.25	207.0	77.5	18.1	30.09
36	15.7	1130	36.2	30		1	33.96	4.57	2.16	3.44	207.0	77.5	14.7	30.10
I						Ethyl alcohol	59.29 per cent.	Sp. gr. = 0.915						
40	22.4	1110	45.1	30	ignition[a]	1–56/64	49.02	6.42	2.19	3.49	206.0	78.0	16.7	30.12
41	15.9	1130	37.0	30		1–53/64	40.96	5.37	2.58	2.96	206.0	78.0	14.1	30.12

[a] 13° before H. E. D. C.

TABLE 3

Results of tests using McCormick-Deering tractor B

TEST NO.	HORSEPOWER AS MEASURED BY BELT	AVERAGE ENGINE SPEED	DURATION OF TESTS	POINT OF IGNITION	FUEL NEEDLE VALVE SETTINGS	FUEL CONSUMPTION				TEMPERATURE		BRAKE THERMAL EFFICIENCIES BASED ON HIGH HEATING VALUES	BAROMETRIC READINGS
										Cooling water	Room		
	b.h.p.	r.p.m.	minutes	degrees	notches	lb. per hr.	gal. per hr.	lb. per b.h.p. hr.	b.h.p.hr. per gal.	degrees Fahr.	degrees Fahr.	per cent	inches of mercury
A				Gasoline Sp. gr. = 0.744									
199	28.7	1002	30	43	1–35/64	21.10	3.31	0.73	8.69	209.0	89.3	17.2	30.09
198	22.5	1038	30	43	1–35/64	16.14	2.62	0.72	8.57	208.0	69.0	17.6	30.07
197	22.5	1038	30	43	1–32/64	16.56	2.67	0.74	8.42	208.0	68.0	17.2	30.07
196	15.3	1068	30	43	1–14/64	12.62	2.04	0.83	7.48	206.0	74.0	15.3	30.04
195	13.3	1091	30	43	1– 4/64	10.84	1.75	0.81	7.15	205.0	74.0	15.5	30.04
B													
202	30.9	1000	30	35	1–35/64	21.60	3.48	0.70	8.86	208.0	76.0	18.1	30.12
201	30.3	995	30	31	1–35/64	22.00	3.55	0.73	8.55	208.5	75.5	17.4	30.12
200	30.2	1000	30	33	1–35/64	21.36	3.44	0.71	8.78	205.0	89.0	17.9	30.09
203	22.6	1042	30	33	1–31/64	15.50	2.50	0.69	9.04	207.0	80.5	18.4	30.17
204	15.7	1068	30	35	1– 4/64	11.92	1.92	0.76	8.13	205.5	80.0	16.6	30.17
C				Kerosene Sp. gr. = 0.808									
207	30.7	998	30	31	1–32/64	20.18	2.95	0.66	10.41	207.5	81.0	19.6	30.20
209a	30.6	990	30	31	1–35/64	20.40	3.03	0.67	10.12	208.0	81.5	19.3	30.20
209b	22.5	1042	30	31	1–27/64	15.40	2.29	0.68	9.85	207.0	81.5	18.8	30.19
206	22.5	1072	30	35	1–28/64	15.82	2.35	0.70	9.60	207.0	82.0	18.3	30.19
205	15.6	1075	30	39	1– 6/64	12.54	1.86	0.80	8.38	205.0	82.0	16.0	30.20
208	10.1	1080	30	43	63/64	11.04	1.64	1.10	6.14	204.0	81.0	11.7	30.20
D				Diluted denatured alcohol Sp. gr. = 0.877									
217	27.5	980	30	43	1–24/64	38.28	5.24	1.39	5.26	205.0	79.0	21.0	29.62
216	25.5	1009	30	43	1–30/64	37.06	5.07	1.45	5.03	204.0	77.0	20.1	29.62
218	16.9	1042	30	43	1–16/64	31.92	4.36	1.89	3.88	204.5	79.0	15.5	29.62
219a	9.4	1068	30	43	1– 8/64	26.56	3.63	2.82	2.59	204.0	80.0	10.4	29.63
219b	20.0	1040	30	43	1–20/64	32.48	4.44	1.63	4.50	204.0	78.0	18.0	29.63
E				Pure denatured alchohol Sp. gr. = 0.824									
214	31.8	983	30	31	1–37/64	36.44	5.32	1.15	5.97	207.5	75.0	19.9	29.67
213b	31.4	997	30	31	1–20/64	33.96	4.94	1.08	6.35	207.5	75.0	21.1	29.67
213a	30.8	993	30	43	1–22/64	33.98	4.94	1.10	6.23	208.0	73.0	20.7	29.70
212	23.9	1038	30	43	1–16/64	28.16	4.10	1.18	5.84	207.0	73.0	19.4	29.70
215	23.3	1042	30	28	1– 5/64	27.30	4.97	1.17	5.86	202.0	77.0	19.5	29.60
211	15.1	1068	30	43	1– 4/64	22.22	3.24	1.47	4.67	204.0	70.0	15.6	29.72
210b	11.2	1082	30	43	58/64	19.48	2.83	1.69	4.06	203.0	70.0	13.5	29.72
210a	22.1	1035	30	31	1– 4/64	25.26	3.75	1.14	5.90	207.0	70.5	20.0	29.72
F				Pure ethyl alcohol 94.3 per cent. Sp. gr. = 0.818									
222	32.3	998	30	27	1–29/64	36.16	5.30	1.12	6.10	208.0	76.5	19.9	30.15
223	30.4	998	30	27	1–15/64	32.00	4.69	1.05	6.47	208.0	76.5	21.1	30.15
221	30.4	992	30	27	1–16/64	32.66	4.79	1.08	6.34	208.0	73.0	20.7	30.15
220	24.3	1036	30	43	60/64	27.78	4.07	1.14	5.97	204.5	73.0	19.5	30.15
224	23.6	1060	30	27	1– 3/64	27.00	3.96	1.14	5.98	206.0	76.5	19.5	30.15
225a	16.7	1068	30	31	58/64	23.64	3.47	1.42	4.80	205.0	77.0	19.7	30.15
225b	22.6	1036	30	43	1	25.49	3.74	1.13	6.05	205.0	76.5	19.8	30.16
225c	12.0	1068	30	43	57/64	19.24	2.82	1.60	4.25	204.0	76.0	13.9	30.16

TABLE 4

Results of tests using cletrac "K" tractor

TEST NO.	HORSE POWER AS MEASURED BY BELT	AVERAGE ENGINE SPEED	DURATION OF TESTS	POINT OF IGNITION	FUEL CONSUMPTION				TEMPERATURE		BAROMETRIC READINGS	BRAKE THERMAL EFFICIENCIES BASED ON HIGH HEATING VALUES
									Cooling water	Room		
	b.h.p.	r.p.m.	minutes	degrees	lb. per hr.	gal. per hr.	lb. per b.h.p. hr.	b.h.p. hr. per gal.	degrees Fahr.	degrees Fahr.	inches of mercury	per cent
A					Gasoline Sp. gr. = 0.744							
111	26.35	1380	36	27.3	19.90	3.21	0.76	8.18	160.0	65.0	29.51	16.7
107	25.22	1382	30	27.3	29.10	4.69	1.15	5.39	163.5	73.0	29.61	11.0
114	25.10	1380	30	27.3	17.68	2.85	0.70	8.81	159.5	71.0	29.57	18.0
108	25.08	1380	30	27.3	17.42	2.81	0.69	8.93	164.0	73.0	29.61	18.2
115	23.10	1400	30	27.3	16.46	2.65	0.71	8.71	157.5	71.0	29.57	17.8
112	20.41	1410	30	27.3	17.96	2.89	0.88	7.05	160.0	70.0	29.51	14.4
113	19.95	1400	30	27.3	15.42	2.49	0.77	8.01	160.0	70.0	29.51	16.4
109a	19.29	1400	30	27.3	15.60	2.52	0.81	7.64	160.0	72.0	29.58	15.6
109b	18.70	1389	30	27.3	15.26	2.46	0.82	7.59	160.0	72.5	29.58	15.5
110	13.01	1450	30	27.3	13.08	2.11	1.01	6.16	158.0	72.5	29.57	12.6
116	6.42	1450	30	27.3	12.16	1.96	1.89	3.27	158.0	72.0	29.58	6.7
B					Kerosene Sp. gr. = 0.808							
117	26.14	1381	30	27.3	25.04	3.71	0.96	7.04	160.0	69.5	29.74	13.9
118a	25.49	1388	30	27.3	17.30	2.57	0.68	9.92	159.0	70.0	29.74	19.7
118b	22.99	1368	30	27.3	16.60	2.46	0.72	9.30	159.0	70.0	29.75	18.5
119	18.71	1400	30	27.3	15.06	2.23	0.80	8.36	156.0	71.0	29.75	16.6
120	13.27	1450	30	27.3	13.04	1.93	0.98	6.86	148.0	71.0	29.75	13.6
121	6.47	1490	30	27.3	10.76	1.60	1.66	4.06	143.0	70.0	29.77	8.0
C					Denatured alcohol Sp. gr. = 0.824							
122	28.90	1400	30	27.3	34.68	5.04	1.20	5.73	166.0	72.0	29.95	19.2
123	25.71	1380	30	27.3	32.34	4.71	1.26	5.46	164.0	74.0	29.95	18.3
124	19.62	1420	30	27.3	27.99	4.07	1.43	4.83	158.0	76.0	29.97	16.2
125	13.10	1421	30	27.3	23.00	3.35	1.76	3.91	151.0	77.0	29.97	13.1
126	6.62	1390	30	27.3	16.80	2.45	2.54	2.71	142.0	80.0	29.99	9.1
D					Diluted denatured alcohol Sp. gr. = 0.877							
127	25.33	1380	30	27.3	45.60	6.24	1.80	4.07	166.0	76.0	29.99	16.9
128	19.88	1400	30	27.3	38.10	5.21	1.92	3.81	160.0	75.5	29.99	15.9
129	13.02	1375	30	27.3	33.51	4.58	2.57	2.84	152.0	75.0	30.00	11.9
130	6.71	1379	30	27.3	28.20	3.86	4.21	1.74	150.5	75.0	30.00	7.3
E					Ethyl alcohol 94.3 per cent. Sp. gr. = 0.818							
131b	29.38	1377	30	27.3	37.80	5.54	1.29	5.31	170.0	79.0	30.03	17.3
131a	29.28	1375	30	27.3	40.20	5.90	1.37	4.97	170.0	79.0	30.03	16.2
132a	26.04	1390	30	27.3	30.18	4.43	1.16	5.89	175.0	76.0	30.03	19.2
132b	25.71	1390	30	27.3	31.41	4.61	1.22	5.58	174.0	73.0	30.04	18.3
133	20.40	1412	30	27.3	26.43	3.88	1.30	5.26	153.0	73.0	30.04	17.2
134	12.99	1410	30	27.3	22.29	3.27	1.72	3.97	150.5	75.0	30.05	13.0
135	6.38	1380	30	27.3	16.77	2.45	2.63	2.61	147.0	75.0	30.05	8.5

TABLE 5

Results of tests using Fordson tractor

TEST NO.	HORSEPOWER AS MEASURED BY BELT	AVERAGE ENGINE SPEED	DURATION OF TESTS	POINT OF IGNITION	FUEL CONSUMPTION				TEMPERATURE		BAROMETRIC READINGS	BRAKE THERMAL EFFICIENCIES BASED ON HIGH HEATING VALUES
									Cooling water	Room		
A	b.h.p.	r.p.m.	minutes	degrees	lb. per hr.	gal. per hr.	lb. per b.h.p. hr.	b.h.p. hr. per gal.	degrees Fahr.	degrees Fahr.	inches of mercury	per cent
					Gasoline	Sp. gr.	= 0.744					
157	22.01	1130	30	50	18.94	3.05	0.86	7.21	209.5	79.0	30.23	14.7
156	21.50	1075	30	50	18.42	2.97	0.86	7.25	209.5	79.0	30.23	14.7
155	20.48	1003	30	50	16.98	2.74	0.83	7.49	209.5	73.0	30.24	15.3
154	20.22	1002	30	43	13.52	2.18	0.67	9.27	209.5	73.0	30.24	18.9
153	18.15	1005	30	43	12.34	1.99	0.68	9.11	209.0	68.5	30.23	18.6
152	17.46	1008	30	41	12.26	1.99	0.70	8.79	208.5	68.0	30.23	18.0
158	15.45	1010	30	41	10.92	1.76	0.71	8.77	208.5	80.5	30.18	17.9
159	10.48	1012	30	50	8.92	1.44	0.85	7.28	208.0	80.8	30.17	14.8
160	5.10	1012	30	55	7.08	1.14	1.39	4.46	206.5	82.0	30.16	9.1
B					Kerosene	Sp. gr	= 0.808					
162	20.78	1002	30	32	14.84	2.21	0.71	9.43	210.0	83.0	30.16	17.9
161	19.49	1010	30	38	13.08	1.94	0.67	10.03	210.0	83.0	30.16	19.1
164	15.83	1020	30	41	11.04	1.64	0.70	9.66	208.5	82.5	30.16	18.4
163	15.39	1012	30	30	12.08	1.79	0.78	8.57	209.0	83.0	30.16	16.3
165	11.06	1010	30	50	9.18	1.36	0.83	8.12	207.0	82.0	30.15	15.5
166	5.83	1050	30	50	7.32	1.10	1.25	5.29	205.5	82.0	30.15	10.2
C					Ethyl alcohol 94.3 per cent.	Sp. gr	= 0.818					
188	21.32	1000	30	53	23.76	3.48	1.11	6.12	209.0	73.0	30.26	20.0
187	20.18	1000	30	55	21.20	3.11	1.04	6.48	208.0	72.0	30.26	21.4
186	15.32	1020	30	55	16.84	2.47	1.10	6.21	207.0	70.5	30.27	20.3
184	11.22	1025	30	55	15.20	2.23	1.35	5.04	199.0	71.0	30.30	16.4
185	10.36	1008	30	55	14.62	2.14	1.41	4.82	200.0	71.5	30.30	15.8
183	5.01	1020	30	55	11.94	1.75	2.38	2.86	192.0	72.0	30.30	9.3
D					Ethyl alcohol 77.69 per cent.	Sp. gr.	= 0.870					
191	21.72	1005	30	55.3	29.82	4.11	1.37	5.28	206.0	75.0	30.27	20.6
190	21.14	1008	30	55.3	28.06	3.87	1.33	5.46	207.0	74.0	30.27	21.3
189	20.12	1000	30	55.3	27.56	3.80	1.37	5.30	205.0	73.0	30.27	20.6
192	15.58	1010	30	55.3	21.00	2.89	1.35	5.38	204.0	76.5	30.27	20.9
193	8.50	1008	30	55.3	17.62	2.43	2.07	3.50	203.0	77.0	30.27	13.6
194a	2.76	1005	30	55.3	13.46	1.85	4.87	1.49	198.0	76.5	30.25	5.8
194b	18.80	1000	30	55.3	24.35	3.36	1.29	5.60	204.5	74.0	30.27	21.7
E					Denatured alcohol	Sp. gr.	= 0.824					
170	22.90	1010	30	41.8	29.08	4.23	1.27	5.42	209.0	76.0	30.20	18.0
169	22.42	1035	30	41.8	28.22	4.11	1.26	5.46	208.5	73.0	30.18	18.2
168	21.88	1010	30	55.0	24.58	3.57	1.12	6.12	208.0	72.0	30.18	20.3
167	22.14	1030	30	55.0	29.00	4.22	1.31	5.25	208.5	70.0	30.20	17.5
171	19.80	1018	30	41.0	22.00	3.21	1.11	6.18	204.0	76.0	30.20	20.5
172	15.47	1020	30	41.0	18.00	2.62	1.16	5.89	198.0	68.0	30.20	19.6
174	11.07	1030	30	41.0	15.52	2.26	1.40	4.89	193.0	68.0	30.20	16.3
173	11.38	1030	30	41.0	16.40	2.39	1.44	4.76	193.0	68.0	30.20	15.8
175	5.17	1020	30	41.0	12.02	1.75	2.33	2.95	192.0	70.0	30.20	9.8
F					Diluted denatured alcohol	Sp. gr.	= 0.877					
182	21.42	1000	30	55	31.80	4.35	1.48	4.93	208.5	73.5	30.20	19.7
180	19.68	1000	30	55	28.96	3.96	1.46	4.99	206.0	73.0	30.20	20.0
181	20.60	1000	30	55	29.90	4.09	1.45	5.03	208.0	73.0	30.20	20.1
176	19.20	1000	30	55	28.10	3.84	1.46	5.01	204.0	68.5	30.20	20.0
177	16.14	1022	30	55	24.60	3.37	1.53	4.79	202.0	68.5	30.20	19.2
178	11.52	1010	30	55	21.16	2.89	1.83	3.98	202.0	70.0	30.20	15.9
179	4.94	1030	30	55	16.80	2.44	3.40	2.02	202.0	70.0	30.20	8.6

TABLE 6

Fuel consumption in pounds per brake horsepower hour at various loads

FUEL	SP. GR.	15-30 MCCORMICK-DEERING A				15-30 MCCORMICK-DEERING B			CLETRAC "K"				FORDSON			
		Percentage of normal load				Percentage of normal load			Percentage of normal load				Percentage of normal load			
		100	75	50	25	100	75	50	100	75	50	25	100	75	50	25
Gasoline	0.744	0.69[a]	0.66	0.90	1.53	0.68	0.67	0.79	0.68	0.79	1.05	1.95	0.66	0.70	0.88	1.40
Kerosene	0.808	0.77[a]	0.72[a]	0.88	1.40	0.65	0.67	0.82	0.70	0.79	1.05	1.73	0.67	0.71	0.88	1.38
Denatured alcohol	0.824	—	—	—	—	1.06	1.13	1.45	1.27	1.45	1.81	2.60	1.11	1.18	1.49	2.09
Denatured alcohol	0.877	—	—	—	—	—	1.51	2.02	1.80	2.04	2.67	—	1.46	1.57	2.03	3.40
Ethyl alcohol	0.818	1.14	1.15	1.50	2.48	1.04	1.13	1.45	1.16	1.37	1.77	2.65	1.04	1.11	1.42	2.38
Ethyl alcohol	0.870	—	—	—	—	—	—	—	—	—	—	—	1.30	1.39	1.85	2.96
Ethyl alcohol	0.892	1.73	1.77	2.23	—	—	—	—	—	—	—	—	—	—	—	—

[a] With the water needle valve open.

TABLE 7

Equivalent amounts of fuel used in terms of the consumption at normal load

FUEL	SP. GR.	15-30 MCCORMICK-DEERING A			15-30 MCCORMICK-DEERING B		CLETRAC "K"				FORDSON		
		Percentage of normal load			Percentage of normal load		Percentage of normal load				Percentage of normal load		
		75	50	25	75	50	115	75	50	25	75	50	25
Gasoline	0.744	0.96	1.30	2.22	0.98	1.16	—	1.16	1.54	2.86	1.06	1.33	2.12
Kerosene	0.808	0.93	1.14	1.82	1.03	1.26	—	1.13	1.50	2.47	1.06	1.31	2.06
Denatured alcohol	0.824	—	—	—	1.06	1.37	0.94	1.15	1.42	2.04	1.06	1.34	1.88
Denatured alcohol	0.877	—	—	—	—	—	—	1.16	1.48	—	1.07	1.39	2.33
Ethyl alcohol	0.818	1.01	1.31	2.17	1.09	1.39	1.09	1.18	1.52	2.29	1.07	1.36	2.29
Ethyl alcohol	0.870	—	—	—	—	—	—	—	—	—	1.07	1.42	2.28
Ethyl alcohol	0.892	1.02	1.79	—	—	—	—	—	—	—	—	—	—

TABLE 8

Equivalent amounts of fuel used in terms of gasoline

FUEL	SP. GR.	15-30 MCCORMICK-DEERING A								15-30 MCCORMICK-DEERING B					
		Percentage of normal load								Percentage of normal load					
		100		75		50		25		100		75		50	
		By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.
Gasoline	0.744	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kerosene	0.808	1.02	1.11	1.00	1.09	0.89	0.97	0.85	0.93	0.98	0.96	0.92	1.00	0.96	1.04
Denatured alcohol	0.824	—	—	—	—	—	—	—	—	1.41	1.56	1.52	1.68	1.65	1.83
Denatured alcohol	0.877	—	—	—	—	—	—	—	—	—	—	1.91	2.25	2.17	2.56
Ethyl alcohol	0.818	1.50	1.65	1.58	1.74	1.50	1.65	1.49	1.64	1.39	1.53	1.53	1.69	1.66	1.83
Ethyl alcohol	0.870	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ethyl alcohol	0.892	2.09	2.51	2.23	2.68	2.04	2.45	—	—	—	—	—	—	—	—

FUEL	SP. GR.	CLETRAC "K"								FORDSON							
		Percentage of normal load								Percentage of normal load							
		100		75		50		25		100		75		50		25	
		By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.
Gasoline	0.744	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Kerosene	0.808	0.95	1.03	0.92	1.00	0.92	1.00	0.81	0.88	0.93	1.01	0.93	1.01	0.92	1.00	0.91	0.98
Denatured alcohol	0.824	1.69	1.87	1.65	1.83	1.55	1.72	1.20	1.33	1.52	1.68	1.52	1.68	1.53	1.69	1.34	1.49
Denatured alcohol	0.877	2.25	2.65	2.19	2.58	2.16	2.54	—	—	1.87	2.21	1.90	2.24	1.96	2.31	2.06	2.43
Ethyl alcohol	0.818	1.54	1.70	1.57	1.73	1.52	1.68	1.23	1.36	1.42	1.57	1.43	1.58	1.46	1.61	1.54	1.70
Ethyl alcohol	0.870	—	—	—	—	—	—	—	—	1.68	1.97	1.69	1.98	1.79	2.10	1.80	2.21
Ethyl alcohol	0.892	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE 9

Brake thermal efficiencies (per cent) at the different loads based on high heating values

FUEL	SP. GR.	15-30 MCCORMICK-DEERING A				15-30 MCCORMICK-DEERING B			CLETRAC "K"				FORDSON			
		Percentage of normal load				Percentage of normal load			Percentage of normal load				Percentage of normal load			
		100	75	50	25	100	75	50	115	100	75	50	100	75	50	25
Gasoline.........	0.744	18.2	18.0	14.3	8.3	18.2[b]	18.3[b]	16.4	—	18.1	15.9	12.0	18.9	17.7	14.4	9.1
Kerosene........	0.808	16.6	17.4	14.7	8.8	19.6[b]	18.7[b]	15.6	—	19.4	16.7	12.9	19.1	18.0	14.6	—
Denatured alcohol	0.824	—	—	—	—	21.1	20.0	16.7	19.1	18.1	15.7	12.1	20.5	19.4	15.4	9.8
Denatured alcohol	0.877	—	—	—	—	—	19.2	14.8	—	16.2	14.8	11.3	20.1	18.5	14.5	8.7
Ethyl alcohol....	0.818	19.3	19.2	15.0	8.8	21.1	19.7	16.2	18.3	19.0	16.3	12.2	21.4	20.0	15.5	9.3
Ethyl alcohol....	0.870	—	—	—	—	—	—	—	—	—	—	—	21.6	20.5	15.5	9.3
Ethyl alcohol....	0.892	18.1	17.9	14.5	8.8	—	—	—	—	—	—	—	—	—	—	—

[b] With water injection.

TABLE 10

Equivalent amount of fuel used in terms of gasoline

TRACTOR	PER CENT LOAD	Kerosene Sp. gr. = 0.808		DENATURED ALCOHOL				ETHYL ALCOHOL							
				Pure Sp. gr. = 0.824		Diluted Sp. gr. = 0.877		94.3% by vol. Sp. gr. = 0.818		77.69% by vol. Sp. gr. = 0.870		69.3% by vol. Sp. gr. = 0.892		59.29% by vol. Sp. gr. = 0.915	
		By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.
McCornick-Deering 15-30 H.P. Compression ration 4.24															
Engine A	100	1.02	1.11					1.50	1.65			2.09	2.51		
	75	1.00	1.09					1.58	1.74			2.23	2.68	2.70	3.32
	50	0.89	0.97					1.50	1.65			2.04	2.45		
	25	0.85	0.93					1.49	1.64						
Engine B	100	0.98	0.96	1.41	1.56			1.39	1.53						
	75	0.92	1.00	1.52	1.68	1.91	2.25	1.53	1.69						
	50	0.96	1.04	1.65	1.83	2.17	2.56	1.66	1.83						
Cletrac "K" 15-25 H.P. Compression ratio	100	0.95	1.03	1.69	1.87	2.25	2.65	1.54	1.70						
	75	0.92	1.00	1.65	1.83	2.19	2.58	1.57	1.73						
	50	0.92	1.00	1.55	1.72	2.16	2.54	1.52	1.68						
	25	0.81	0.88	1.20	1.33			1.23	1.36						
Fordson 20 H.P. Compression ration 4.22	100	0.93	1.01	1.52	1.68	1.87	2.21	1.42	1.57	1.68	1.97				
	75	0.93	1.01	1.52	1.68	1.90	2.24	1.43	1.58	1.69	1.98				
	50	0.92	1.00	1.53	1.69	1.96	2.31	1.46	1.61	1.79	2.10				
	25	0.91	0.98	1.34	1.49	2.06	2.43	1.54	1.70	1.80	2.11				

TABLE 11

Most economical consumption in pounds per brake horsepower hour

FUEL	SP. GR.	MCCORMICK-DEERING TRACTORS		CLETRAC "K" TRACTOR	FORDSON
		15-30 H.P.			Compression ratio 4.22
		Compression ratio 4.24			
		A	B		
Gasoline	0.744	0.65	0.66	0.70	0.66
Kerosene	0.808	0.72	0.64	0.66	0.67
Ethyl alcohol—94.3%	0.818	1.11	1.02	1.16	1.04
Ethyl alcohol—77.7%	0.870	—	—	—	1.28
Ethyl alcohol—66.3%	0.892	1.70	—	—	—
Ethyl alcohol—59.3%	0.915	—	—	—	—
Denatured alcohol	0.824	—	1.06	1.20	1.10
Denatured alcohol	0.877	—	1.39	1.80	1.56

TABLE 12

Maximum brake horsepower hours per gallon of fuel

FUEL	SP. GR.	MCCORMICK-DEERING TRACTORS		CLETRAC "K" TRACTOR	FORDSON
		15-30 H.P.			Compression ratio 4.22
		Compression ratio 4.24			
		A	B		
Gasoline	0.744	9.25	9.12	8.90	9.25
Kerosene	0.808	9.25	10.40	9.90	10.05
Alcohol, ethyl—94%	0.818	6.12	6.48	5.90	6.50
Alcohol, ethyl—77.7%	0.870	—	—	—	5.60
Alcohol, ethyl—69.3%	0.892	4.35	—	—	—
Alchol, ethyl—59.3%	0.915	—	—	—	—
Denatured alcohol	0.824	—	6.40	5.75	6.20
Denatured alcohol	0.877	—	5.25	4.05	5.03

THE BUNCHY-TOP OF ABACÁ AND ITS CONTROL[1]

G. O. OCFEMIA
Of the Department of Plant Pathology

WITH SIX TEXT FIGURES

THE DISEASE

History, geographical distribution and economic importance

The bunchy-top of abacá is probably an old disease in the Philippines although abacá farmers in Cavite believe that it first broke out in Silang in 1915; it did not, however, become serious until about 1923 (Ocfemia, 1930).

Ocfemia (1926, 1930) considers bunchy-top as one of the most serious diseases of abacá. Bunchy-top is responsible for the destruction of abacá fields in Paete, Laguna Province and in many fields in Cavite Province abacá culture has been abandoned and the land planted to rice, corn, coconut, and other crops. Bunchy-top occurs in the College of Agriculture at Los Baños, Laguna. It was from the College plantation that the writer obtained materials for his experiments since April, 1925, to date. On August 9, 1930, bunchy-top was noted on abacá plants along the road and in some of the towns in Tayabas Province.

Although abacá is very seriously infected by bunchy-top in Laguna and Cavite provinces the writer in 1930 reported that he had not seen the disease on Philippine varieties of banana and plantain.

At present, abacá bunchy-top is known definitely in the provinces of Cavite, Laguna, Tayabas, and Davao. The former Bureau of Agriculture reported bunchy-top in several other places (Teodoro, 1925). Since at the time this bureau reported the distribution of bunchy-top and up to 1927 Dr. N. G. Teodoro and Mr. F. B. Serrano, Plant Pathologists of the bureau, reported that *Heterodera radicicola* (Greef) Müller causes the disease, in part, not much credit may be given to the report. In Queensland, Australia, abacá and a seedy musaceous species, *Musa banksii*, a plant native of north Queensland are reported to be affected by the bunchy-top of banana (Anon. 1925, 1926). Gadd (1925) reports that abacá was infected by the bunchy-top from plantain in the Peradeniya Experiment Station in Ceylon.

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[1] Experiment Station contribution No. 743.

The writer's work on bunchy-top of abacá is still in progress. This paper was prepared to include all the results obtained by the writer from his experiments since April, 1925, to date.

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HOW BUNCHY-TOP MAY BE RECOGNIZED

Early stage of the disease

On the leaves. In the writer's experiments on aphid-transmission of abacá bunchy-top under controlled conditions at Los Baños, the first symptom noted is the presence of yellowish white and indefinite chlorotic areas on the blade of the youngest furled leaf. These areas are clearly shown on the margins and lamina of the youngest leaf (fig. 1b). When the leaf which shows the first symptoms is fully expanded the green portions of the blade on either side of the midrib are darker green than those of the leaves of healthy abacá plants. The discolored areas are thinner than the rest of the blade and are often retarded in their growth. As a result, the

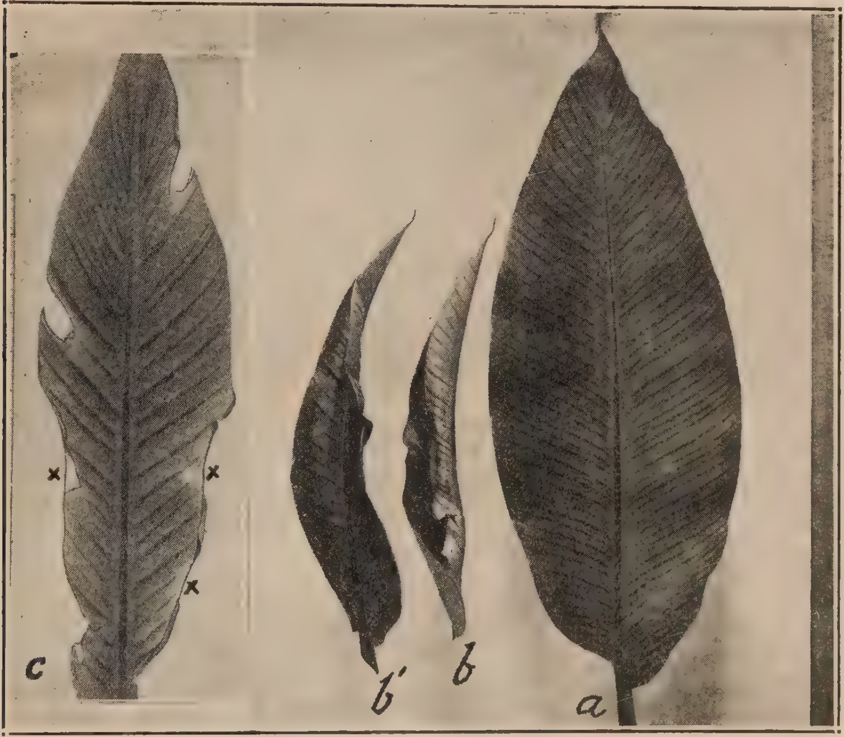

Fig. 1.—(*a*) A leaf of a healthy abacá plant fully expanded. (*b*) A leaf of a diseased abacá of the same age as the healthy plant from which (*a*) was taken. The leaf (*b*) shows the yellowish white and indefinite chlorotic areas on the blade, and it is curling and tearing along the margin. (*b'*) Another leaf showing the curling along the margin as compared with the fully expanded leaf (*a*) from a healthy plant. (*c*) A young leaf of abacá, C. A. 4293 Itom, affected with bunchy-top from aphid-transmission experiment on August 17, 1926, showing the membrane-like areas (*x*) along the margin of the leaf. The membrane-like tissues on the upper part of the leaf were torn off.

All photographs except fig. 1c. by the Photographic Division, Soils Department, College of Agriculture. Fig. 1c. from photograph by the Bureau of Science, Manila.

leaves curl upwards or tear along the margin. Delicate. thin and transparent membrane-like areas of varying shapes and sizes may be formed on the thin chlorotic portions of the youngest leaf either before it unfurls or immediately after (fig. 1c). If held in the light the main veins of the leaves showing the symptoms appear as transparent lines. On the main veins these transparent lines are continuous from the midrib to the margin. They are about one-half of a millimeter in width. On the secondary veins they are broken into dashes one- to five-millimeters in length. On both surfaces of the leaves these dashes appear yellow. If the leaf is still furled the transparent lines appear water-soaked. In some varieties of abacá, dark green streaks which vary from mere dots to lines several millimeters long may be seen (fig. 2b). The long green streaks may start from the midrib and disappear as they reach the borders of the chlorotic areas of the infected leaves. The dark green lines are also about one-half of a millimeter wide. They are occasionally present on the midrib, petiole, and leaf blades. Frequently these dark green streaks may be seen on the plant only in the more advanced stage of the disease.

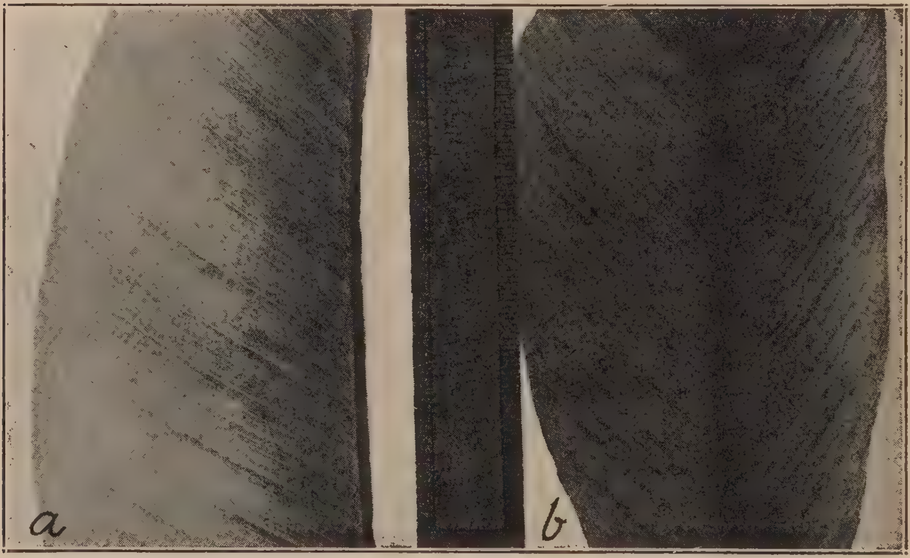

Fig. 2.—Back view of small portions of the leaves of (*a*) healthy and (*b*) a diseased abacá, variety Inosa photographed in transmitted light on February 6, 1928. Note the dark green streaks between the veins of the leaf in (*b*). The specimens were collected from suckers of infected stools which were more than two years old. The plant was infected in an experiment on aphid-transmission of bunchy-top conducted in November, 1925.

The leaf which shows the first symptom of the disease is usually shorter and narrower than the leaf which was produced before the plant was attacked. The narrowing of the leaf blades sometimes continues down to within a few centimeters of the midrib. Owing, perhaps, to its narrowness the leaves of diseased plants unfurl much more readily than the leaves of healthy plants. Furthermore, the leaves of diseased plants have a tendency to curl up along their margin and they are stiffer than the leaves of healthy abacá.

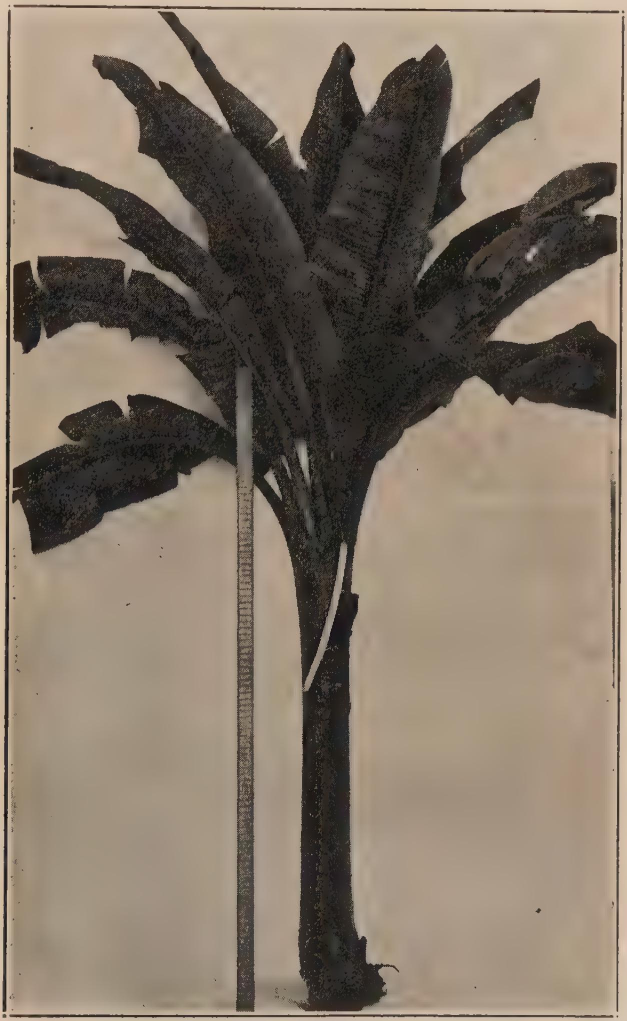

Fig. 3.—A typical bunchy-topped abacá showing the curling of the leaves along the margin and the bunching and rosette arrangement of the leaves. Note that the diameter of the false stem at the base and just below the petioles are about the same. Note further that the petioles arise from the same plane. The specimen was collected from the abacá field of the Department of Agronomy of the College of Agriculture at Los Baños and photographed on January 16, 1926.

On the false stem. The green portions of the leaf sheaths of infected plants are darker in color than the green portions in healthy abacá As soon as an abacá plant is infected the new, or innermost leaf sheaths begin to become as short as (fig. 3 and 4), or shorter than the one immediately next to it. As the disease advances the petioles begin to arise from nearly the same level at the upper end of the false stem, and as a result the leaves are borne in a more or less rosette arrangement (fig. 3 and 5b, b′).

On the roots. Ocfemia (1930) reports that in the early stage of bunchy-top the root systems are the same in extent and in color as those of the healthy abacá plants.

Advanced stage of the disease

On the leaves. As the disease advances the new leaves produced become progressively narrower and shorter than the one immediately below and are stiff. In healthy abacá plants the expanded youngest leaf is longer and wider than the leaf next to it until the plants begin to flower. The leaves of abacá with the advanced stage of bunchy-top are malformed and in many cases even aborted. They are much reduced in size and curled upwards along the margin. The margins are chlorotic and the discoloration extends towards the midrib in the form of irregular diffuse streaks with their long axes parallel with the veins.

In some cases of bunchy-top infection of abacá the thin chlorotic areas along the margin turn brown and die starting from the edge of the leaf (fig. 4) or from any of the thin and transparent membrane-like patches (fig. 1c). The death and browning of the leaf blades sometimes continue until the midrib is reached. Often the dead thin chlorotic portions involve the entire length of the youngest furled leaf. During the wet season the dead tissues rot and sometimes this rotting continues downwards producing heart-rot. Ocfemia (1927) reports that under favorable conditions the rotting of the central cylinder may extend as far as the corm. From 11 to 17 per cent of the plants finally die of heart rot.

On the false stem. As the youngest leaf sheaths are shorter than the outer older ones the false stems of diseased abacá are much shorter than those of healthy plants of the same age. The girth at the top of the false stem of diseased plants may be the same as, or greater than, that at the base. This is due to the fact that the shortening of the inner leaf sheaths forces the bases of the petioles outwards. In healthy abacá plants the false stems are long, and they taper gracefully towards the upper end because the petioles are set farther apart and the youngest leaf sheath is the longest (fig. 5a).

Infected abacá plants may remain alive for more than two years but they gradually become smaller and smaller until finally all of the leaves and leaf sheaths turn brown and die. Thus far, of all abacá plants infected with bunchy-top that have been observed none have fruited.

On the roots. In the advanced stage of the disease the roots of the infected abacá plants gradually turn dark-colored, die and rot. Various fungi and bacteria may be found in the rotting roots. Ocfemia (1930) believes that in advanced stages of bunchy-top the death of the roots is

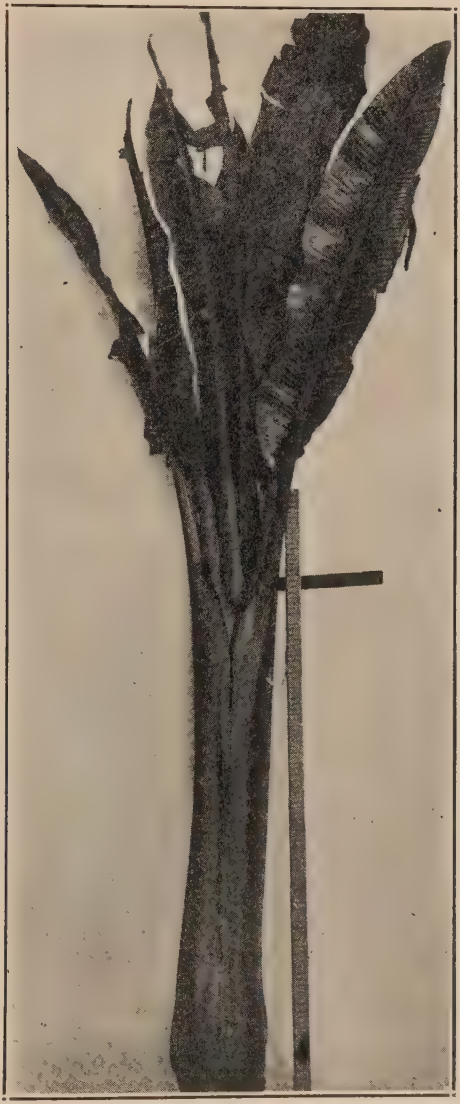

Fig. 4.—An advanced stage of bunchy-top infection of abacá showing the even diameter of the false stem from the base to the upper end, the crowding of the leaves, and the plane from which the petioles arise. Note that the margins of the inner leaves are dead and rotting and dark colored. The specimen was collected from the abacá field of the Department of Agronomy and photographed on January 16, 1926.

from starvation, the result perhaps, of the inability of the diseased plant to furnish them with sufficient organic foods. The rotting of the roots therefore occurs as a result rather than as cause of bunchy-top.

Abacá plants attacked by bunchy-top are stimulated to produce numerous undersized suckers. These suckers have small and stiff leaves with curled up margins. On the leaves of the suckers the characteristic symptoms of bunchy-top and the chlorosis are much more pronounced than on the leaves of plants which were infected from outside sources.

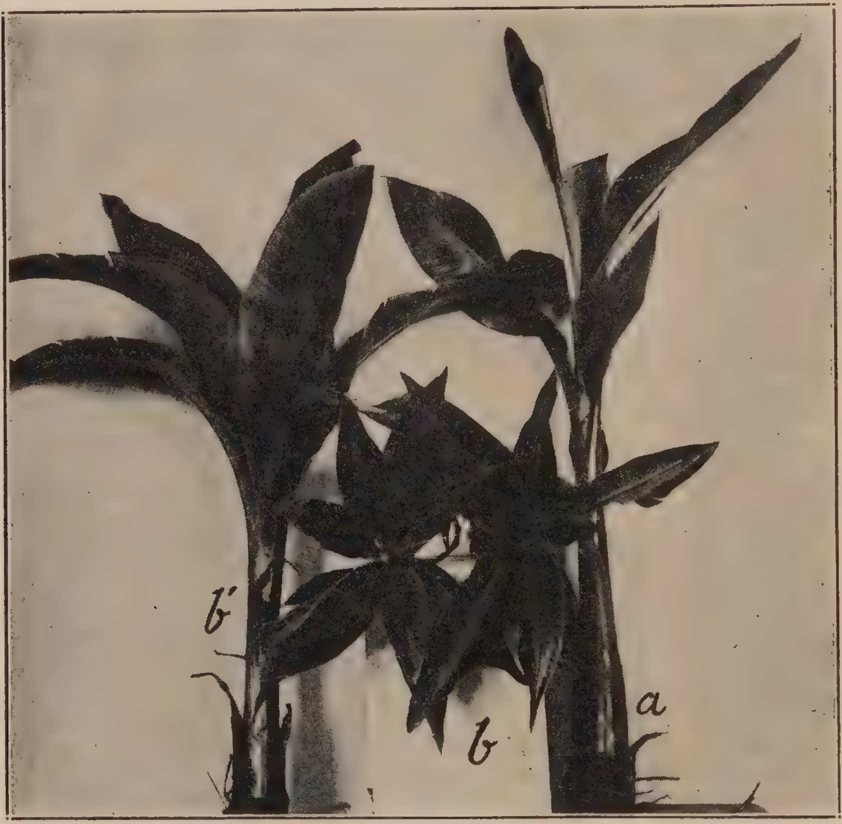

Fig. 5.—(*a*) A healthy abacá plant showing the graceful tapering of the false stem from the base to the tip. It also shows that the leaves are progressively longer and wider and are arranged farther apart. (*b*) The rosette arrangement of the leaves of two infected abacá suckers as seen from above. (*b'*) An affected abacá plant of the same age as that in (*a*) showing the crowding of the leaves, the shortened false stem, and the curling of the leaves along the margins.

CAUSE OF BUNCHY-TOP AND WAYS THE DISEASE IS SPREAD IN THE FIELD

In the Philippines the results of the writer's experiments in the Department of Plant Pathology of the College of Agriculture at Los Baños conducted from April, 1925 to date show conclusively that bunchy-top is a virus disease. The disease is very much like the transmissible and deleterious chloroses which are spread by sucking insects. Bunchy-top of abacá is transmitted from plant to plant in the field by the aphid, *Pentalonia nigronervosa* Coq.[2] (Ocfemia, 1926, 1930.) The appearance of the youngest leaf of abacá infested with this aphid is shown in figure 6.

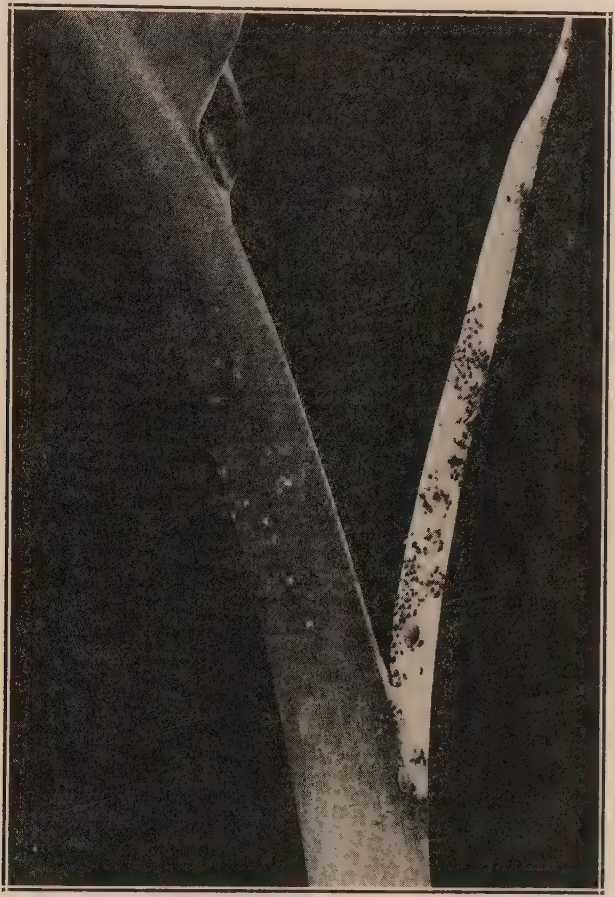

Fig. 6.—A young furled leaf of an abacá sucker (about 30 cm. from the soil to the base of the petiole of the next youngest leaf) showing a large number of the aphid, *Pentalonia nigronervosa* Coq. The plant from which this specimen was taken was infected with bunchy-top. The specimen was collected from the abacá field of the Department of Agronomy and photographed on November 21, 1925. About natural size.

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[2] During the writer's work on transmission of bunchy-top of abacá with *Pentalonia nigronervosa* as vector it was noted that during the rainy season many of the aphids are killed by the fungus parasite *Cephalosporium crassum* Petch. The fungus undoubtedly helps to reduce the number of this aphid considerably.

The aphids are spread in the field in two ways. The winged forms, though not capable of prolonged flight, may be carried to plants at some distance by the wind. In the field, ants are very important agents in spreading *Pentalonia nigronervosa.*

HOW BUNCHY-TOP MAY BE CONTROLLED

Exclusionary measure

There are Administrative Orders (Teodoro, 1925) which were approved with the object of preventing the spread of abacá bunchy-top. If the government cannot maintain an effective quarantine against bunchy-top, individual abacá planters should make every effort to keep the disease from spreading, not only from one abacá district to another but from plantation to plantation.

Bunchy-top can certainly be kept from completely destroying the abacá industry of the Philippines if each planter will do his share in the control of this most destructive disease of abacá known. All efforts should be exerted to prevent bunchy-top being spread from locality to locality, especially to the important abacá localities or plantations. This can be done by prohibiting the movement from the infected areas to other abacá localities of all abacá, banana and their relatives or parts of them, with the exception of the clean fiber of abacá, banana, canton, and pacol.

Also, care must be taken to prevent the spread of the aphid *Pentalonia nigronervosa,* because bunchy-top is transmitted from plant to plant by this aphid, and thus far only abacá, banana and their close relatives have been found to be hosts of this aphid. Hence it is most important to prohibit the moving from locality to locality not only of suckers and corms of abacá, banana, and their close relatives but also of soil taken from abacá or banana fields. The use of leaf sheaths of banana and leaves of abacá and banana for wrapping propagative plant materials and perishable products for shipment from the bunchy-top-infected regions to the important abacá growing districts is extremely dangerous. For infected aphids may be carried on the corms, on or between the leaf sheaths, within the intercellular spaces at the cut ends of the petioles and leaf sheaths, on leaves of living plants and with the soil containing portions of roots and corms of abacá. The result of observations made by the writer at the College of Agriculture since 1925 has shown that in dry weather and immediately after heavy rains the aphids may be found on the corms, among the roots, at the bases of plants, between leaf sheaths and in the intercellular spaces at the cut ends of the petioles and leaf sheaths.

Extermination of the disease and protection of the plantation

Should bunchy-top finally find its way into the more important abacá provinces, localities or plantations in spite of exclusionary measures, it is most important that entire stools of abacá as well as other members of the genus *Musa* which show symptoms of bunchy-top, be dug up immediately, chopped in pieces *in situ* and sprayed with a dilute solution of either Black Leaf "40", black leaf "40" and soap solution, tobacco decoction, nicotine sulfate, *Derris* spray or soap solution. The soil around the stools should also be sprayed. For applying the spray a "Flit" pump may be used satisfactorily.

The formulae and directions for the preparation of these spray solutions are given by Dr. L. B. Uichanco of the Department of Entomology of the College of Agriculture as follows:

Tobacco decoction

Tobacco stems (factory refuse)	500 grams
Hot water	8 to 12 liters

To prepare tobacco decoction steep the tobacco stems in hot water but never allow the mixture to boil because nicotine, which is the active insecticidal substance in the tobacco, is very volatile. It will be driven off by boiling.

Black Leaf "40"

Black Leaf "40"	125 cc.
Water	50 to 100 liters

Black leaf "40" is a concentrated solution of nicotine. It contains about 40 per cent nicotine. It is a trade name for a product manufactured by the Tobacco By-Products and Chemical Corporation, Inc., Louisville, Ky., U.S.A.

Black Leaf "40" and soap solution

Black Leaf "40"	65 cc.
Soap (ordinary laundry)	500 to 750 grams
Water	100 liters

The addition of soap appears to increase the adhesive property of the mixture.

Nicotine sulfate

40 per cent nicotine sulfate	1 part by volume
Water	800 parts by volume

According to Doctor Uichanco, in the formulae calling for nicotine sulfate or Black Leaf "40" hard water is preferable to soft water. Rain water is unsatisfactory for this purpose. The harder the water the more readily nicotine volatilizes.

If Black Leaf "40", tobacco decoction, and nicotine sulfate are not available *Derris* spray may be used instead.

Derris (tubli) spray

Derris roots	1 kilogram
Water	10 liters

Pound the roots of *Derris* thoroughly and macerate them in water over-night. Strain through cloth. For use take one part of the infusion and dilute it with ten parts of water.

For *Pentalonia nigronervosa* Doctor Uichanco states that ordinary soap solution may be used effectively.

Soap solution

Fish-oil soap	500 grams
Water	12 to 20 liters

If no fish-oil soap is available, common laundry soap may be substituted.

For destroying *Pentalonia nigronervosa* the writer used, in his experiments, about one cc. of commercial Black Leaf "40" in 1500 cc. of tap water in which about five grams of laundry soap had been dissolved.

After spraying the chopped pieces of the diseased abacá plants and the soil around them the corms of the infected plants should be burned until they are cooked so that they will not sprout and furnish infectious materials for the aphids. This measure is recommended in a locality where the disease is of recent introduction so as to save the whole plantation, and in new plantings in totally devastated fields like those in Laguna and Cavite provinces where farmers are contemplating reviving the abacá industry.

Immunization

Bunchy-top of abacá infects the important members of the genus *Musa.* It is not known whether varieties of abacá which are highly resistant to the disease may be developed eventually. In the writer's work at Los Baños it was noted that all varieties of abacá used are infected by bunchy-top in the same degree. He used plants from suckers, plants grown from seeds, and first generation variety hybrids (Ocfemia, 1930). There seems very little hope of developing resistant forms of abacá. Crossing abacá with wild species might give resistant forms but there is danger that this may reduce the quality of the fiber produced.

REHABILITATION OF THE ABACÁ INDUSTRY[3]

The abacá industry in the completely devastated areas of Cavite and Laguna provinces may be reëstablished if all suspected abacá, banana and their relatives are completely eradicated, the land rested for nine to twelve months, and proper precautions taken that the corms of infected plants do not produce new shoots. After this period of rest the vacated places may be replanted with healthy suckers taken from regions known to be entirely free from bunchy-top, or plants grown from seeds. Occasional infection of replaced abacá plants is due to our inability to recognize the presence of the aphid which carries the infectious material from diseased to healthy abacá plants.

The infectious material of bunchy-top is drawn from the plant by the aphid with the sap of the abacá on which it feeds. This infectious material, however, is not transmitted to the young which are born of the infected adult aphids. With this knowledge there is considerable assurance that as soon as the infected parent aphids are dead there is no fear of their young causing infection. The only source of infectious material for the young aphids are diseased plants of abacá, banana and their relatives.

In 1928 the Department of Plant Pathology of the College of Agriculture started this work on an experimental scale in Indang, Cavite, using a hectare of an old bunchy-top-devastated land. Plants used in the reëstablishment of the abacá industry should be started either from seeds or from suckers obtained from districts absolutely free from bunchy-top. Although abacá grown from seed requires a longer period to reach maturity and productiveness, nevertheless it is easier to transport and handle and it eliminates the chance of obtaining plants with latent stages of bunchy-top and prevents the introduction of aphids. In either case, during the first few months, the young plantings should be carefully inspected at intervals of 30 to 40 days. Every part of each plant should be looked over. Any bunchy-top case found during each inspection should be dug up, chopped to pieces *in situ* and sprayed with the aphicide and the corm destroyed completely by burning. The effectiveness of the eradication work and the success of the rehabilitation work will depend upon one's ability to diagnose accurately the early symptoms of bunchy-top of abacá. All aphid-infested plants, including the ground immediately about them, should be sprayed with an aphicide and these plants should be watched with suspicion.

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[3] This information was first given out by the writer in College of Agriculture News Service No. 14, issued April 8, 1931, entitled "Can the bunchy-top devastated abacá fields in Laguna and Cavite provinces be revived?" published in English, Spanish and Tagalog.

SUMMARY

1. Bunchy-top is a most destructive disease of abacá.

2. The disease is first shown by whitish indefinite streaks on the blades of the furled leaves. This is followed by the curling of the margin of the expanded leaves and then by the bunching of the petioles on the upper part of the false stem. The false stem does not increase in length, and the diameter at the upper end may be the same as the diameter at the base. At first the roots do not show any effect from bunchy-top but as the disease advances the roots rot. Infected plants become smaller and smaller until they finally die after about two years. In advanced cases of the disease from 11 to 17 per cent of the plants die of heart rot.

3. Bunchy-top is caused by a virus which is spread from plant to plant by the aphid *Pentalonia nigronervosa* Coq.

4. The disease may be prevented from destroying the abacá industry by prohibiting the movement of abacá, banana, and their relatives, or parts of these and of soil from infected areas, districts or plantations to localities or plantations where the disease does not occur.

5. If the disease breaks out in a locality or plantation extermination and protective measures should be enforced.

6. Up to the present time no varieties of abacá are known to be resistant to bunchy-top.

7. Completely devastated abacá plantations may be revived if precautions like those given in this paper are followed.

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A STUDY OF THE RESPIRATION OF THE CHICO, ACHRAS ZAPOTA LINN[1]

L. G. GONZALEZ
Of the Department of Agronomy

WITH ONE TEXT FIGURE

In an earlier paper (1927) the writer showed that fully matured but unripe chico fruit becomes edible within 24 to 36 hours after treatment with carbon dioxid gas. The fruit remains hard and crisp but every trace of astringency is lost. Such fruit ripens within 10 days. Treatment with the gas for a longer period, that is over 48 hours, is more effective in making the fruit non-astringent but it remains hard, does not soften, a behavior that is obviously undesirable. The writer has also observed in connection with his work on the cold storage of the chico that if this fruit in an unripe stage is placed at 0°C. its appearance remains unchanged for some time; the fruit never ripens, although it keeps fresh for a period of three weeks. On the other hand, if ripe chico fruit is placed in this same temperature it will remain in excellent condition for about two weeks, a period about four times as long as when the fruit is placed at room temperature of about 28°C. These responses of the chico led the writer to find out possible changes in the respiratory activity of the fruit since this is generally considered to be directly connected with the ripening process.

The experiments here reported were conducted in the Pomology Laboratory of the College from December, 1930 to June, 1931.

MATERIALS AND METHODS

The chico fruits used in these experiments were fully matured, free from all kinds of injury and were fairly uniform in size, color of skin and other external characteristics. Care was used in gathering the fruits so as not to subject them to any unnecessary handling. They were washed carefully at the same time brushing off the bloom from the surface of the fruit; they were then air-dried in the laboratory and arranged for sampling. The fruits were chosen by pairs for similarity in appearance, size, and color. The pairs were then separated into two lots, constituting samples 1 and 2. The samples were weighed in an accurate balance, the aim being to get as close to one kilogram as possible. In all cases the number of fruits in the two lots was the same and the weights of the samples did not vary more than five grams.

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[1] Experiment Station contribution No. 744. Read before the Los Baños Biological Club, June 25, 1931. Received for publication July 7, 1931.

The carbon dioxid output of the fruits was determined by the titrametric method. The fruits were placed in a dessicator the side of which was carefully sealed with thick vaseline and further coated with two layers of shellac and tested for air leak by submersion in water. Two exits on top of the dessicator properly connected with pieces of glass and rubber tubings offer a good means of testing the apparatus for possible leak. One of the exits was closed with a pinch-cock while a gentle blow on the other end of the rubber tubing caused a slight pressure which proved to be very efficient in determining any opening on the dessicator, however minute the size of the hole. The dessicator was then attached to a series of carbon dioxid-washing solutions contained in a relay of Erlenmeyer flasks, connected by glass and rubber tubings. This carbon dioxid-cleaning mixture was made up of a bottle of dry soda-lime, two flasks of saturated potassium solution, two flasks of strong barium hydroxide solution and a bottle of dry calcium chloride crystals. To the other end of the dessicator was connected a suction flask fitted with a Reiset tube about half a meter tall containing a layer of fine glass beads suspended by a perforated rubber stopper. This tube in turn was connected to a trap bottle, then to a bottle containing dry soda lime, then to the aspirator. The dessicator was placed in a properly insulated water bath. Figure 1 shows a picture of the whole apparatus.

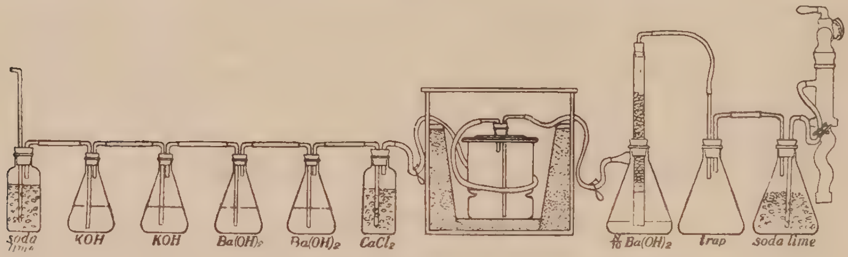

Fig. 1.—Showing apparatus used in the experiment

Two temperatures were used. In one set of experiments 0°C. was used; in this case the bath was filled with crushed ice, completely covering the dessicator; in the other set the temperature of the water in the bath was 28.5°C. It is unfortunate that no thermostatic control could be fitted into the bath but because of the good insulation and constant checking, the temperature never varied more than 0.2°C. throughout the experiment.

Two lots were run each time. Air was drawn at least twelve hours before any determination was made of the carbon dioxid output of the fruit. Tenth-normal barium hydroxide was used for absorbing the carbon dioxid. Titration with tenth-normal oxalic acid showed the amount of alkali used by the fruit. The amount of carbon dioxid was calculated from this and the values were expressed in milligrams carbon dioxid per kilogram of fruit per hour duration of the experiment. The barium hydroxide used was always in excess of the estimated CO_2 from the fruit.

In the latter part of the experiment the samples were treated with certain doses of carbon dioxid. This was done by passing the gas resulting from the action of hydrochloric acid on ground marble, through a bottle of rain water for absorption of hydrochloric acid fumes, and letting in the carbon dioxid through one of the exits of the dessicator, after which the two exits in the dessicator were closed until the desired length of time of treatment was reached. To avoid fluctuations in temperature, the fruits were not taken from the bath during any treatment.

EXPERIMENTS AND RESULTS

Experiment 1. There were 13 fruits in each lot. Sample 1 weighed 990 grams and sample 2, 1,000 grams. Both samples were placed in the dessicators, all connections fitted, tested for air leak, then the dessicators were placed in the bath and covered with ice and the air was drawn off immediately. The first measurement was begun 24 hours after starting the current of air. In addition to the fruits used for measurement of carbon dioxid, 30 chicos were placed in a separate container also in ice, and 20 in another container at laboratory temperature. For convenience these will be called lots 3 and 4, respectively.

On December 20, 1930, 48 hours after the setting of the experiment, two fruits from lot 4 were ripe while all of those in lot 3 were still hard; no apparent change was noted. The next day almost all the fruits in lot 4 were ripe. Two days later they were beginning to show signs of overripening. This gave the chicos in lot 4 a storage life of 5 days.

All of the fruits in lot 3 were in a very fresh condition, looking apparently normal after a storage life of 22 days. The fruit was still astringent at the end of the experiment. Samples taken daily from the ice bath and placed in laboratory temperature, up to 5 days, ripened normally three days after exposure to the warmer temperature. Fruits allowed to stay in ice for more than five days and exposed to laboratory temperature showed increasing signs of discoloration. The computed carbon dioxid output of the fruit in lots 1 and 2 are shown in table 1.

Experiment 2. Each of the two lots contained 15 fruits and weighed one kilogram each. The apparatus was set after all precautions were taken to minimize error. The first determination was made 12 hours after running the aspirator. The temperature of the bath was kept constant at 28.5°C. Observations on ripening were taken on fruits placed in other jars used as control.

TABLE 1

Respiration of the chico at 0°C.

DATE	TITRATION NUMBER	DURATION OF EXPERIMENT	MGM. CO2 PER KGM. HOUR	
			Sample 1	Sample 2
1930		*hours*	*mgm.*	*mgm.*
December 19	1	9	3.01	3.18
	2	14	3.11	3.18
20	3	4	3.07	3.33
	4	4	3.37	3.44
21	5	17	3.37	3.29
	6	4	3.53	3.54
	7	3	6.82[a]	4.29[a]
22	8	8	——	——
	9	3	——	3.21
23	10	16	3.51	3.52
	11	6	3.57	3.94
24	12	18	3.62	——
26	13	5	3.64	3.03
	14	17	3.53	3.39
27	15	7	3.52	3.11
	16	16	3.31	3.38
1931				
January 2	17	6	——	2.79
5	18	8	1.98	1.79
	19	16	2.02	1.89
6	20	7	1.76	1.76
	21	16	1.62	1.77
7	22	7	1.52	1.51
8	23	16	1.35	1.27
	24	8	1.23	0.98
9	25	17	1.19	1.16

[a] Air-leak was discovered.

A few fruits ripened two days after setting of the experiment, the rest on the third day, and some fruits showed signs of decay on the sixth day. As the evolution of carbon dioxid was rather excessive, the duration of the experiments did not exceed 3 hours. The results of the determinations are shown in table 2.

Experiment 3. Two other lots of fruits were selected. Both contained 15 fruits. Lot 1 weighed 950 grams and lot 2, 952 grains. The lots were prepared on June 14 and the first reading for carbon dioxid evolution was made 12 hours later. Three determinations were made, after which lot 1 was treated with carbon dioxid for 13 hours without taking the dessicator from the bath which was maintained at 28.5°C. The dessicator was attached to the carbon dioxid-purifying solutions and readings were taken the following day. The treated fruits ripened at about the same time as

TABLE 2

Respiration of the chico at 28.5°C.

DATE	TITRATION NUMBER	DURATION OF EXPERIMENT	MGM. CO_2 PER KGM. HOUR			
			Sample 1	Daily average	Sample 2	Daily average
1931		*hours*	*mgm.*	*mgm.*	*mgm.*	*mgm.*
May 12	1	1.50	38.65		54.27	
	2	2.83	57.85		56.25	
	3	3.00	62.66		58.38	
	4	3.00	50.93	52.52	60.21	57.27
13	5	2.00	———		67.25	
	6	2.00	69.63		70.18	
	7	3.00	70.63		72.12	
	8	3.00	66.95	69.07	71.10	70.16
14	9	2.00	82.61		80.20	
	10	2.00	82.17		81.04	
	11	2.00	83.38		80.25	
	12	2.00	76.56	81.18	79.58	80.27
15	13	2.00	63.47		79.24	
	14	1.80	82.95		78.10	
	15	2.25	75.02		71.21	
	16	2.00	74.36	73.95	70.11	74.66
16	17	2.00	59.89		55.12	
	18	1.50	48.40	54.14	50.27	52.69

those in the control lot. The fruits softened at the third and fourth days. There was no decrease in astringency that could be attributed to the carbon dioxid treatment. The experiment lasted 6 days. The results of the carbon dioxid measurements are shown in table 3.

TABLE 3

Influence of carbon dioxide treatment on the respiration of the chico at 28.5°C.

DATE	TITRATION NUMBER	DURATION OF EXPERIMENT	MGM. CO_2 PER KGM. HOUR			
			Sample 1	Daily average	Sample 2	Daily average
1931		*hours*	*mgm.*	*mgm.*	*mgm.*	*mgm.*
June 15	1	1	56.96		38.82	
	2	1	49.26		58.97	
	3	2	50.48	52.23	55.50	51.09
16	4	2	Treated with CO_2 for 13 hours		60.25	
	5	2			62.23	
16	6	2			59.27	60.58
17	7	1	61.57		65.20	
	8	2	56.04		64.65	
	9	2	48.63		70.28	
	10	2	61.36	56.90	72.21	68.09
18	11	2	97.26		109.34	
	12	2	99.23		99.88	
	13	2	95.52	97.34	104.50	104.57

Experiment 4. An experiment similar to those described above was conducted, the only difference being that the fruits in one dessicator were treated with carbon dioxid for 38.5 hours instead of 13. Both lots contained 16 fruits. Lot 1 weighed 1001 grams and lot 2, 1002 grams. The treated fruits became non-astringent after 48 hours. They remained firm after the non-treated fruits had decayed. Flavor was normal up to the eighth day. Increasing signs of grittiness and drying followed. The results of the titration for carbon dioxid output are shown in table 4.

TABLE 4

Influence of CO_2 treatment on the respiration of chico at 28.5°C.

DATE	TITRATION NUMBER	DURATION OF EXPERIMENT	MGM. CO_2 PER KGM. HOUR			
			Sample 1	Daily average	Sample 2	Daily average
1931		*hours*	*mgm.*	*mgm.*	*mgm.*	*mgm.*
June 19	1	2	53.24		61.25	
	2	2	55.32	54.28	63.30	62.27
20	3	2	Treated with CO_2 for 38.5 hours		80.25	
	4	2			87.60	83.92
21	5	2			93.37	
	6	2			95.21	94.29
22	7	2	48.18		117.70	
	8	2	48.20	48.19	119.68	118.68
23	9	2	41.80		69.30	
	10	2	41.80		76.34	
	11	2	57.20	46.93	83.27	
	12	2	81.62[a]		96.58	81.37

[a] Two fruits were found to be moldy.

DISCUSSION OF RESULTS

The average rate of carbon dioxid output of the chico at 0°C. for the first nine days was 3.38 milligrams per kilogram per hour. The respiratory activity was more or less uniform during this time. On the fourteenth day the carbon dioxid given off began to decrease and at the end of 21 days the amount was not quite one-half (average of 1.18 mgm.) of the initial rate.

The fruits did not ripen when kept in ice for more than five days, although, in appearance, they remained normal for 22 days. On the other hand ripe chicos were not adversely affected by this low temperature and it was obvious that certain physiological activity associated with the ripening process was arrested or at least greatly minimized. The chico is primarily a fruit the ripening process of which has to undergo a great deal of hydrolysis from the insoluble forms of carbohydrates and gummy substances to the simpler forms of sugars and all these call for enzymatic action, transforming from one form to another so that any inhibiting influence in any step may cause a certain amount of injury.

As to this abnormal behavior of the fruit at low temperature, the banana (Pascual, 1930) and the papaya (Enrile, 1930) behave in a similar manner. These fruits also possess insoluble forms of carbohydrates, necessitating changes for the formation of the final forms of sugars. On the other hand fruits that do not contain an appreciable amount of starch, as the orange, the lemon and the pomelo behave very well at low non-freezing temperatures (Gonzalez, 1927).

Comparing the carbon dioxid output of the chico at 0°C. with that at 28.5°C., the rate was increased by at least 19 times in favor of the higher temperature. Of course such an increase may be expected in accordance with the vắn't Hoff-Arrhenius postulation. But the increase in rate in this case is rather great and perhaps is the largest that has been reported.

It my be noted in tables 2, 3, and 4 that variations among determinations within each day are rather large but the daily averages are fairly uniform. Basing calculations on these averages, the respiration rate at 28.5°C. increased steadily up to the fourth day then decreased until decay began to set in. The highest rate of respiration coincided with the ripening period. The findings of Gerber (1896), Gore (1914), Magness (1920), and others suggest that the greatest amount of sugar formation takes place at this time which may partly account for the highest peak in respiratory activity.

When the chicos were treated with carbon dioxid for 13 hours there was only a slight decrease in carbon dioxid output as compared with that of the control. The same treatment was not efficient in rendering the chico non-astringent and did not affect the ripening of the fruit to any appreciable degree. A longer treatment of 48 hours removed all traces of astringency but this resulted in inhibiting the softening process in the fruit. It is interesting to note that a carbon dioxid treatment of only 38.5 hours caused the reduction in respiratory activity of the fruit by at least 50 per cent. Treatment of a longer duration would probably cause more reduction. It is thus shown that there is a close relationship between harmful treatments and diminution in carbon dioxid output in chico.

SUMMARY AND CONCLUSIONS

1. The method of determining the respiratory activity of the chico is described.

2. The rate of respiration of the fruit at 0°C. remained fairly uniform for the first nine days with an average output of 3.38 milligrams per kilogram-hour. The rate began to decrease on the fourteenth day with an average of 1.18 on the twenty-second day.

3. Chicos placed on ice and moved to laboratory temperature (27° to 32°C.) ripened normally provided they were not left at 0°C. over 5 days. When kept on ice for a longer duration, the fruit did not ripen normally.

4. The average respiratory rate of the fruit at 28.5 was 66.59 milligrams or about 19 times that at 0°C.

5. There was an increase in rate of respiration, the highest rate coinciding with the time of ripening of the fruit and perhaps with the stage at which most sugar was synthesized.

6. Treatment with carbon dioxid for 13 hours gave a slight reduction in the respiratory activity of the fruit, while an exposure for 38.5 hours reduced the rate of respiration to about 40 per cent of the control.

7. There seems to be a direct relationship between the harmful treatments and diminution in respiratory activity of the chico.

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THE PROSPECTS OF COTTON PRODUCTION IN THE PHILIPPINES[1]

EULALIO P. BALTAZAR
Of the Department of Agronomy

Because of the suggestion recently advanced with some insistence from certain quarters that the cotton industry in the Philippines be revived, it seems pertinent at this time to examine analytically the conditions governing this crop in the various Philippine provinces where it is grown.

During the Spanish régime, considerable cotton was grown, principally in the provinces of La Union, Pangasinan, Ilocos Sur, Ilocos Norte, and Abra, in Luzon. The produce was converted locally into yarns for home weaving. In the days of the Tobacco Monopoly, however, the Government discouraged the planting of cotton in order that tobacco production might be extended. It is worthy of note, nevertheless, that long after the Tobacco Monopoly had passed into history, the planters in Ilocos Norte, Ilocos Sur, and La Union continued to find in tobacco a more profitable crop than cotton, and indications are that the area devoted in those provinces to the tobacco leaf is steadily increasing. By way of illustrating this tendency, the towns of Tubao, Rosario, Luna, Naguilian, and Bauan in La Union may be cited. These towns produced some cotton in the early days, but they have almost completely abandoned this crop in favor of tobacco. Hence, the following comparative table of land areas devoted to tobacco in 1902 and 1918 is illuminating:

Province	Hectares in tobacco	
	1902	1918
Ilocos Norte	655	1,861
Ilocos Sur	91	842
La Union	3,149	13,266

These three provinces are selected for statistical comparison, because they have been relatively the largest cotton producers in the Philippines.

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Ilocos Norte and Ilocos Sur alone had, in 1902, an aggregate area of 2,236 hectares devoted to cotton, or about 73.2 per cent of all the area planted to this crop in the entire Archipelago. Again, it is significant that by 1918, cotton acreage in these two provinces had dwindled to 1,403 hectares, or only 63 per cent that of 1902. For that matter, even if the whole Archipelago were considered, a considerable reduction in figures is noted between these two dates, for in 1918 there were only 2,115 hectares planted to cotton, as against 3,053 hectares in 1902, or a reduction of 936 hectares in sixteen years. Likewise, while the island of Luzon in 1902 had a cotton acreage of 2,918 hectares, in 1918 it had only 2,098.

It will thus be seen that in the early years of the century cotton growing in the Philippines decreased considerably. Moreover, it may be mentioned in passing that whatever cotton is grown, especially in the Ilocano provinces, is not in pure stands, but is intercropped with corn. The result is that the cereal crop tends to crowd out the fiber crop in the field and in this way further lessen the already dwindling production. It is not tobacco and corn alone to which cotton is giving way; a great deal of the former cotton land now produces sugar cane and rice. Also, since the construction of the irrigation system in the northern provinces, some of the fields that used to be planted, by rotation, to rice and to cotton are now planted exclusively to rice. Perhaps, the figures for cotton lands would be somewhat higher were it not for the fact that many of the older cotton fields, like those in the barrios of General Terreno, General Trin, Cag-gao, Maria Cristina, Bangaoilan, Unsueygra, Kinterangon, and Cruz, in the municipalities of Bangar and Sudipen, in La Union Province, have suffered from erosion by the Amburayan River.

Several reasons may be adduced to explain the decrease of cotton production in the Philippines. The most important, however, is certainly the mounting importation of cotton and cotton goods from foreign countries where the natural advantages make this a profitable crop to grow. The principal sources of imported cotton products are the United States, Great Britain, France, Germany, Japan, China, Spain, and Switzerland. In the five-year period from 1925 to 1929, inclusive, the annual importation into the Islands averaged ₱53,595,660.60. This amount is a trifle less than three times that for 1909. In 1929, our importation of cotton yarns alone amounted to ₱1,476,811.00. Even the local weavers use imported cotton yarn in preference to the home product. The reason for this preference is that they find in the imported yarn a uniformly more dependable source of supply; moreover, its price is lower, even if they buy it from middlemen. In the Philippines, it takes a great deal of time and tedious work to raise cotton and convert it into yarn, in view of the necessarily primitive methods employed in the manufacture. Likewise, silk yarns, which are also imported are to some extent supplanting cotton in weaving certain fabrics, as *tapis*, kerchiefs, and piece goods. The price of silk yarns has gone down considerably in recent years, so that people of average means can afford to wear silk apparel without seriously impairing their pocketbooks. The towns of Bantay, Cauayan, and Santa in Ilocos Sur, now weave more silk textiles than cottton. In San Nicolas and Laoag, although these are the two most important cotton-producing towns in Ilocos Norte, most of the weavers make only silk textiles.

Locally woven cotton cloth suffers in competition with the imported. Our methods of weaving are antiquated, slow, and tedious, and, consequently, very expensive. People of average means who formerly did their own weaving now prefer to buy imported cloth and thus free themselves for pursuit of more profitable occupations.

Moreover, the School Uniform Law has further limited our market for clothes of local weave, for the *kinoros* cloth, as the product of the Ilocano native loom is called, does not meet the specifications of this law. The school children are therefore obliged to wear imported cotton clothes. Incidentally, there is, likewise, the growing feeling that inevitably develops in a country with improving economic conditions that wearing apparel made from imported textiles is more desirable or, to put it differently, more stylish.

A further reason for the decline of the cotton industry in the Philippines is that many of the Ilocanos who go to Hawaii or the United States own small land holdings. Before leaving, some sell their property to owners of large farms. Much of the land planted to cotton under the small farmers is converted by the new owners into tobacco or rice fields. Most of the large land holders do not allow their tenants to plant fields to cotton, being convinced that other crops give better returns.

To sum up, the principal reasons for the diminishing cotton acreage in the Philippines are (1) the prevalent low prices, due largely to competition with imported yarn and textiles; (2) decreasing demand; and (3) antiquated methods of harvesting and ginning the crop, of converting the crop into yarn, and of weaving the yarn into cloth. The antiquated methods could be changed; but certainly there is no way of escape from low prices and lack of demand, except by the doubtful means of artificial legislation. Indeed, that a crop is demonstrably capable of being grown in this country is not a sufficient basis to justify advocating its extensive planting. The farmer is out to make money, and not to amuse himself by growing curiosities of questionable economic value. And certainly not at this time, when Southern United States is reported to be considering burning one-third of its cotton crop in order to alleviate condition of the world's oversupply!

A STUDY ON THE SALT REQUIREMENTS OF COCO-SEEDLINGS GROWN IN POTS[1]

GREGORIO R. BRIONES

INTRODUCTION

In 1924, Espino and Juliano, and in 1925, Luzuriaga reported studies on absorption of culture solutions by coco-palm seedlings. The present study deals primarily with the effects upon the growth and development of coco-seedlings of these same solutions and seven culture solutions of Shive's 3-salt type I (1915) added to common garden soil in pots.

Espino and Juliano found that the rate of absorption of some culture solutions of Shive's 3-salt type I varied according to the molecular proportion of the component salts. These same investigators obtained similar results from Espino's best culture solution of the 4-salt type I (1920). They found that the 4-salt culture solution most readily absorbed by individual roots of the coco-palm was characterized by one part each of monopotassium phosphate, calcium nitrate, and ammonium sulfate, and 5 parts of magnesium sulfate. Of the culture solutions of Shive's 3-salt type I tried, the solution characterized by 2 parts each of monopotassium phosphate and magnesium sulfate, and 3 parts of calcium nitrate was found by these authors to be the most readily absorbed by the roots of the coco-palm. In 1925, Luzuriaga modified the 4-salt culture solution used by Espino and Juliano (1924) with an addition of a moderate amount of sodium chloride and found that the culture solution thus modified was more readily absorbed by the roots of the coco-palm of different ages than the same solution without the common salt.

The studies on the salt requirement of the coco-palm thus far carried out in this College have been confined to the rate of absorption of different culture solutions by individual roots of the palm. It was thought that it would be valuable and interesting to determine the relative influence of these few selected culture solutions on the growth and development of the coco-seedlings when the entire root system of each palm was supplied with a complete culture solution. A set of cultures was started but owing to the lack of sufficient distilled water the work was discontinued.

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It was then decided to apply, separately, these few selected culture solutions to soil[2] in pots in which coconut seedlings of apparently uniform stand were planted, one seedling to each pot. This is the study reported in this paper. The results obtained may serve as a guide in the selection and preparation of fertilizer mixtures to apply to coconut plantations. The results may further be considered as a contribution to the very limited knowledge of the salt requirement of coco-seedlings. They show plainly the relative nutritive values of the different culture solutions that have been added separately to common garden soil in pots where coco-seedlings were growing.

The experimental work of the present study was conducted in the College of Agriculture, Los Baños, Laguna, during the period from September 13, 1925 to January 30, 1926—a period of about 4-1/2 months, so that the pots were still adequate for the plants.

MATERIAL AND METHODS

The seedlings

Nuts of the Laguna type having similar shape and size were planted in a seed bed of sawdust. At the age of one month, seedlings of apparently uniform development were selected and carefully dug up out of the seed bed. The seedlings were planted in large earthen pots (*pilones*) each having 1,256 sq. cm. surface area and containing 28,000 cc. of the common garden clay-loam soil. In each of these pots a seedling was planted and a certain kind of nutrient solution was added.

The culture solutions

Single-salt stock solutions. The single-salt stock solutions were prepared separately in half molar concentration by using distilled water as the solvent and "Baker's analyzed" monopotassium phosphate (KH_2PO_4), calcium nitrate ($Ca(NO_3)_2$), magnesium sulfate ($MgSO_4$), and ammonium sulfate $(NH_4)_2SO_4$). The sodium chloride ($NaCl$) was prepared in one molar concentration. Ferric phosphate ($FePO_4$) was used as a source of iron.

Culture solutions. The stock culture solutions were prepared by combining three or four salts in the gram molecular proportions, as indicated in table 1 and as were prepared by Espino and Juliano (1924), Luzuriaga (1925), and Shive (1915).

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[2] Unfortunately not analyzed; but the same kind of soil was used throughout this study.

TABLE 1

Showing gram-molecular proportions of each of the culture solutions found to be readily absorbed by coco-palm roots by other investigators, and other cultures of the 3-salt type

CULTURE SOLUTION	KH_2PO_4	$Ca(NO_3)_2$	$MgSO_4$	$(NH_4)_2SO_4$	NaCl
Espino–Juliano–A_4	0.0192	0.0192	0.096	0.0192	
Espino–Juliano–E_3	0.014	0.021	0.014	——	
Luzuriaga–C_2	0.0192	0.0192	0.096	0.0192	0.5 cc. of NaCl added to every 99 cc. of Espino - Juliano - A_4 culture solution
Luzuriaga–C_3	0.0192	0.0192	0.096	0.0192	1.0 cc. of NaCl added to every 99 cc. of Espino - Juliano - A_4 culture solution
Control culture	None	None	None	None	
Shive–3-salt solution					
R_1C_1	0.0045	0.0045	0.0405		
R_1C_5	0.0045	0.0225	0.0225		
R_1C_9	0.0045	0.0405	0.0045		
R_5C_1	0.0225	0.0045	0.0225		
R_5C_3	0.0225	0.0135	0.0135		
R_5C_5	0.0225	0.0225	0.0045		
R_9C_1	0.0405	0.0045	0.0045		

The pot cultures

After mixing the solutions, the amount of the culture solution that should be added to each culture was determined. The results obtained from the preliminary absorption experiments which were discontinued owing to lack of sufficient distilled water for the purpose, showed that a coco-seedling about two months of age was able to absorb about 16 cubic centimeters of a culture solution in a day; in one week, therefore, it would be able to absorb 112 cubic centimeters. But, owing to the power of the soil to absorb salts, it was thought best to double this amount of the culture solution for each pot. The application, then, of the fertilizing ingredients to a pot filled with soil almost to the brim was made at the rate of 250 cubic centimeters of a culture solution a week. Each culture type was run in duplicate. The cultures were exposed to the same climatic conditions.

EXPERIMENTS AND RESULTS

Appearance of plants

At rather frequent intervals, the appearance of the plants in all the cultures was observed. As a rule, the plants appeared quite healthy and all developed normally. In the control culture, however, the plants were rather inferior to the plants which received the application of the fertilizing ingredients. At the beginning, the control plants were apparently as healthy and vigorous as any of the plants, but later the fertilized cultures were better in growth and development than the unfertilized cultures.

Measurements of growth

To be able to determine the relative effectiveness of the different culture solutions tested, the growth of the leaves of each seedling was measured at three-day intervals. The measurements, begun soon after the seedlings were set in the pots, were continued for about four and one-half months. Owing to lack of space the data obtained on growth measurements are not here published. The total growth increments for the period are the following:

Espino-Juliano–A_4	386.45 cm.
Espino–Juliano–E_3	341.95 "
Luzuriaga–C_2	412.90 "
Luzuriaga–C_3	368.35 "
Control (no fertilizer)	259.15 "
Shive–3-salt type:	
R_1C_1	271.70 "
R_1C_5	268.15 "
R_1C_9	309.50 "
R_5C_1	272.95 "
R_5C_3	284.95 "
R_5C_5	266.10 "
R_9C_1	306.30 "

Criteria of result at the time of harvest

Weight of fresh shoot and root. At the time of harvest, the weight of each fresh shoot, as well as the fresh weight of the root system of each culture, was determined. The data obtained from all the cultures tested are shown in table 2. The average of the weights of the shoots, and of the lengths of the roots in each of the duplicate cultures were computed. The results appear in table 2.

TABLE 2

Weight of fresh shoots and roots at the time of harvest

CULTURE SOLUTIONS	Plant	WEIGHT OF		AVERAGE	
		shoots	roots	shoots	roots
		grams	*grams*	*grams*	*grams*
Espino–Juliano–A_4	1	574.5	227.9		
	2	465.8	215.0	520.4	221.4
Espino–Juliano–E_3	1	360.0	183.5		
	2	431.6	200.0	395.8	191.7
Luzuriaga–C_2	1	784.9	265.9		
	2[a]	415.0	180.0	599.9	223.2
Luzuriaga–C_3	1	442.8	180.7		
	2	621.3	239.8	532.0	210.2
Control	1	271.1	138.2		
	2	290.9	154.4	331.0	146.3
Shive–R_1C_1	1	303.6	172.4		
	2	323.1	184.4	313.3	178.4
Shive–R_1C_5	1	240.4	120.9		
	2	327.8	226.4	284.1	173.6
Shive–R_1C_9	1	332.0	163.4		
	2	282.8	183.9	207.4	178.6
Shive–R_5C_1	1	256.4	114.8		
	2	305.3	175.7	280.8	145.2
Shive–R_5C_3	1	300.0	160.9		
	2	276.3	148.0	288.1	154.4
Shive–R_5C_5	1	320.3	185.8		
	2	288.0	173.4	304.1	179.6
Shive–R_9C_1	1	324.2	172.0		
	2	207.0	187.6	315.6	179.8

[a] One leaf was accidentally destroyed about one month after the cultures were started, hence lower records.

Number of leaves. All the leaves produced by all the cultures were apparently normal. It is important that the number of leaves produced by each culture be determined. Countings were made and the data obtained are recorded in table 3.

DISCUSSION OF RESULTS

The results of the present study seem to show several interesting and valuable results—suggesting the way for a more effective investigation on the salt requirements of coco-seedlings and in connection with the application of commercial fertilizers to the young coco-palm. The results obtained are discussed under separate headings in following paragraphs.

TABLE 3

Showing the number of leaves at the time of harvest

CULTURE SOLUTIONS	plant	LEAVES	
		per plant	average
Espino–Juliano–A_4	a	7	
	b	6	6.5
Espino–Juliano–E_3	a	6	
	b	6	6.0
Luzuriaga–C_2	a	7	
	b	6[a]	6.5, 7 actually formed
Luzuriaga–C_3	a	7	
	b	5	6.0
Control	a	5	
	b	6	5.5
Shive–R_1C_1	a	6	
	b	6	6.0
Shive–R_1C_6	a	5	
	b	5	5.0
Shive–R_1C_9	a	6	
	b	6	6.0
Shive–R_5C_1	a	5	
	b	6	5.5
Shive–R_5C_3	a	5	
	b	6	5.5
Shive–R_5C_6	a	6	
	b	5	5.5
Shive–R_9C_1	a	6	
	b	6	6.0

[a] One leaf was destroyed about one month after the cultures were started.

Appearance of the plants

As mentioned elsewhere in this report, the plants in all the cultures appeared to have developed normally. The leaves were of normal green color. There were, however, differences in the size of the plants, as were observed at the time of harvest. The differences will be pointed out, presently. To the influence of fertilizing ingredients, the plants responded, apparently, in the size of the plants, that is, height of the shoot, size of leaves, and the size of the root system, rather than in the color of the leaves and in general appearance. The apparent good growth of the plants in all the cultures seems to indicate that the weekly additions of the culture solutions to the soil had not produced total concentrations which were really harmful to the young plants.

Effects of the culture solutions

As indicated by the relative rate of growth of leaves. The sum total of the growth increments of the different leaves of the two coco-seedlings in each duplicate culture (see p. 355) were somewhat variable. But if the comparatively high growth increments and the relatively low growth increments are considered, it will be seen that interesting results were obtained. It is here proposed to consider all the growth increments exceeding eight centimeters as relatively *high rate,* and the growth increments not exceeding four centimeters as *slow rate.*

Considering the mass of data[3] in the terms just proposed, it was found that each of the cultures that received applications of Espino-Juliano-A_4 and of Luzuriaga-C_2 nutrients solutions had the largest number of frequencies of the *high rate* of growth increments. Both of these cultures had the least number of frequencies of the *slow rate* growth increments. Therefore, as compared with the other culture solutions, these two culture solutions may be considered as the most nutritively valuable. The sum total of the different growth increments of the leaves in each duplicate culture show also that these two cultures had the highest records. The plants grown with the Espino-Juliano-A_4 mixture had a total of 386.5 centimeters leaf growth; while those grown with the Luzuriaga-C_2 solution, which was a modification of the first one by the addition of a little common salt, (NaCl) showed a growth of 412.9 centimeters. None of the results obtained from the cultures which served as controls and those which were supplied with any of the nutrient solutions of Shive-3-salt type, compare favorably with those obtained from either the Espino-Juliano-A_4 or Luzuriaga-C_2 culture solutions.

As indicated by length of roots. The cultures that received applications of the Espino-Juliano-A_4 and Luzuriaga-C_2 mixtures also showed a better development of the root systems than any of the other cultures. The Espino-Juliano-A_4 mixture produced a root system from the duplicate cultures with an average aggregate root length of 707.3 centimeters per plant[4]; and the duplicate cultures supplied with Luzuriaga-C_2 produced an average aggregate root growth of 715.1 centimeters per plant[4]. Each of the two records was higher than the similar records obtained from the other cultures.

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[3] Owing to lack of space these data are not here published; they are in the files of the Department of Plant Physiology.

As indicated by weights of fresh shoots and roots. Inspection of the data in table 2, shows that in term of the weights of fresh shoots and roots, Espino-Juliano-A_4 and Luzuriaga-C_2 mixtures each produced comparatively heavier tops and roots than those produced by any of the other cultures. Each of these two cultures was about 40 per cent more efficient, nutritively, than the control cultures, or any of the culture solutions of Shive-3-salt type tested.

As indicated by number of leaves. As shown by the data in table 3, the two cultures, (Espino-Juliano-A_4 and Luzuriaga-C_2), which showed more nutritive efficiency (in term of the criteria here employed), were undoubtedly more beneficial to the coco-seedlings and decidedly more suitable to the plants than any of the other cultures, or mixtures.

Efficiency of the 4-salt and of the 3-salt cultures compared

Under all the criteria of results used in this study, the 4-salt culture solutions were nutritively more efficient than the 3-salt culture solutions tried. A more thorough comparison of the efficiency of these nutrient solutions may be made by studying the data in table 2.

In table 2 it may be seen that the Espino-Juliano-A_4 mixture produced an average of 520.4 grams of fresh shoots. This yield was more than the yield that was obtained from any of the eight culture solutions of the 3-salt type; the highest yield of fresh tops from the 3-salt type of nutrient solution being only 395.8 grams, and the lowest yield, 280.9 grams. Therefore, the highest yield of fresh tops, 520.4 grams, was approximately 30 per cent greater than the highest yield obtained from the 3-salt type of culture solutions, and nearly 50 per cent greater than the lowest yield obtained from the pot culture that was fertilized with Shive-R_5C_1 nutrient solution.

This finding suggests that ammonium sulfate, $(NH_4)_2SO_4$, which was the main difference between the 4-salt and the 3-salt solutions tested[5], was beneficial to the palm, at least at its seedling stage. This conclusion corroborates Bacomo's results obtained in 1917 from field cultures and suggests the advisability of adding ammonium sulfate to common garden soil if it is desired to accelerate the development of coco-seedlings grown therein. As shown in table 1, Espino-Juliano-A_4 culture was characterized by having one part each of monopotassium sulfate, (KH_2PO_4); calcium nitrate, $Ca(NO_3)_2$; and ammonium sulfate $(NH_4)_2SO_4$; and five parts of magnesium sulfate ($MgSO_4$). This proportion of the four salts was exactly the same as the proportion of the same salts found by Espino in 1920 as the most suitable for the young rice plant; except that for rice the concentration of the culture solution was very much lower than that found by Espino and Juliano (1920) and that found in the present study, as the best for the coco-seedlings. The two plants, rice and coconut, seem to be tolerant to a rather heavy application of magnesium sulfate—a peculiarity which seems to suggest a relatively high demand for Mg and for SO_4 ions.

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[4] The table containing these data is on file in Department of Plant Physiology.

[5] Probably the soil contained also ammonium salts but being a well aërated soil, the amount present therein was inadequate for the proper need of the plant. Hence, when $(NH_4)_2SO_4$ was added, the plants improved in growth.

Influence of moderate application of sodium chloride

Certain data obtained from the present study show that addition of a small amount of common table salt to Espino-Juliano-A_4 culture solution influenced favorably the root and top developments of the coco-seedlings. An addition of twice the amount of this salt proved somewhat detrimental to the palm. This harmful effect was probably accentuated by the weekly application of the solution to the soil in the pots; for there was an accumulation of the common salt, which made it toxic rather than stimulating as it was when applied in only a moderate amount. This case is shown by the results obtained from Luzuriaga-C_3, a culture solution identical with Espino-Juliano-A_4 except that 1 cubic centimeter of sodium chloride in molar concentration was added to every 99 cubic centimeters of the Espino-Juliano-A_4 solution. Better results were obtained from Luzuriaga-C_2, a culture solution identical with Espino-Juliano-A_4 to which 0.5 cubic centimeter of common salt in molecular concentration had been added to every 99.5 cubic centimeters of the standard nutrient solution.

Culture solutions readily absorbed by individual roots nutritively effective when added to soil in pots

The results from this study show that Luzuriaga-C_2, which in 1925 was found to be the most readily absorbed by single roots of the coco-palm, was found also in this experiment to be most beneficial to coco-seedlings grown in pots. This solution was found by Luzuriaga even more readily absorbed by the roots of the coco-palm than the original Espino-Juliano-A_4 solution, or any of Shive-3-salt culture solutions. This finding is corroborated by certain results obtained from the present study, which results seem to suggest that the rate of absorption of culture solutions, (a criterion which can be employed conveniently only in the study of salt requirements of large coco-palms and was tentatively employed by previous investigators), is a fair indication of the nutritive value of such culture solutions for the coco-palm.

SUMMARY OF CONCLUSIONS

1. A more rapid growth of the leaves and a greater fresh weight of tops and roots of the coco-seedlings were obtained from the soil cultures that received the 4-salt culture solution (Espino-Juliano-A_4, characterized by having one part each of KH_2PO_4, $Ca(NO_3)_2$ and $(NH_4)_2SO_4$; and five parts of $MgSO_4$) than was obtained from any of the pot cultures that received 3-salt culture solutions,—indicating that the addition of $(NH_4)_2SO_4$ was beneficial to the plant.

2. As with young rice plants, the coco-seedlings were found to be tolerant to a rather heavy application of magnesium sulfate, a peculiarity which seems to indicate a heavy demand for Mg which is known to be needed for the formation of chlorophyll and for the production of oil or a heavy demand for the SO_4 ion.

3. A still more rapid growth of the leaves and a higher yield of tops and roots of the coco-seedlings were obtained from the pot cultures that received Luzuriaga-C_2, a culture solution identical with Espino-Juliano-A_4, except that 0.5 cubic centimeter of sodium chloride in molecular solution was added to every 99.5 cubic centimeters of the Espino-Juliano-A. The use of a moderate amount of sodium chloride seems to be invigorating to the coco-seedlings; but a heavier application, rather harmful.

4. The rate of absorption of culture solutions by single roots of the coco-palm previously reported by Luzuriaga (1925) was found in this study to be a fair indication of the nutritive value of such culture solutions for the palm.

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EXCHANGE NOTES

It has been claimed by a certain authority on agriculture that if all the plants in the world were destroyed and the grasses alone remained, man would still be able to exist. When it is realised (writes E. P. Phillips in *South African Grasses*) that probably 60 per cent of the total diet of the whole of the 1,700 millions of human beings in the world comes from the grass family, the above statement is not so far fetched.

—*The Agricultural Gazette*, June, 1931. (New South Wales.)

A Manawatu farmer last spring was having a considerable amount of trouble and loss through his stock blowing on the young fresh grass. He was holding a considerable amount of silage from the previous season, and as an experiment decided to try and get his cows to take to silage again, although doubtful with an amount of fresh grass available. The cows not only took readily to it, but the trouble with blowing ceased.

—*The New Zealand Journal of Agriculture*, February 20, 1931.

In 1929 the pack of Hawaiian canned pineapple was over 9 million cases and estimates of the 1930 production place the output at nearly 11 million cases, which is appreciably higher than in any previous year. The estimated area in bearing in Hawaii is 50,000 acres, but the American interests which control the industry are known to be seeking further areas in which pineapple canning may be started. This may, in part, be due to the temporary exhaustion of some of the Hawaiian lands, or to the possibility of such a contingency in the future. It has also been suggested that there are signs that production will suffer from the onset of pests, but whatever the reason may be, recent pack statistics do not reveal any decline. . . .

The industry in Formosa is growing fairly rapidly; in 1926 about 5,500 acres were under pineapple cultivation, and by 1929 the area had increased to over 9,000 acres with 71 factories, which produced over 20 million cans of all sizes, in operation. The greater part of the export trade is with Japan and Korea, but exports to other countries are growing, and last year (1930) for the first time shipments were made to the United Kingdom. . . .

It seems fairly clear that on the whole the world output of canned pineapple is likely to increase materially in the next few years.

At the same time, there seems no reason to believe that world consumptive power is likely to fall short of absorbing an increased output.

There are still large areas where consumption is comparatively small. Continental Europe, for example, has not so far been a large consumer of canned pineapple; in 1929 exports from the two main sources, Hawaii and Malaya to Europe were appreciably less than one-quarter of the exports to the United Kingdom from these two sources. . . . Apart, however, from Europe, the markets of the East, notably India and China, are very largely undeveloped and should be capable, in course of time, of taking increasingly greater quantities.

—*The Malayan Agricultural Journal,* July, 1931.

There are probably many people who do not know much about the amazing health value of fruit, and who would be surprised to hear that pineapples could be considered as anything more than a very delicious and rather extravagant luxury. The truth is that the curative properties of pineapple are marvelous, and how infinitely more palatable than some obnoxious drug which one's instinct revolts against and is only taken under strong protest.

Pineapple juice is a valuable antiseptic, especially useful in all cases of toxic poisoning. In addition to cleansing and purifying, it is also a restorative of nervous energy and builds up tissue. Sufferers from tonsillitis should squeeze the juice from a thick slice of the fruit, take half as a gargle, and drink the remaining quantity as the most delicious and health-giving cocktail in the world.

—*Tropical Life,* May, 1931.

Little does the ordinary person—the consumer—realize that 72 per cent of the body-building, life-sustaining elements of whole milk are locked up in that portion of the milk below the cream line—in the skim milk.

What happens to this skim milk after the cream has been separated from the whole milk? It not only goes to feed the human element of this world of ours in the form of sweetened condensed skim milk, but it also supplies an important part of the menu in the animal kingdom in the form of semisolid buttermilk, dried buttermilk, and dried skim milk. Besides this, skim milk, in the form of casein, goes into the manufacture of innumerable products, such as glue, coating for paper, substitute for ebony, bone, ivory, amber, coral, etc., for toilet sets, umbrella handles, cigarette holders, fountain pen barrels, poker chips, etc.

—*Concentrated Milk industries,* March, 1931.

Man O'War, the world's greatest race horse, is insured for $500,000, and owned by Samuel D. Riddle 9 miles north of Lexington, Kentucky, U. S. A.

THE COLLEGE OF AGRICULTURE NEWS

Several members of the faculty of the College of Agriculture on the request of the Chairman of the Agricultural Section of the recently organized Philippine Association of Sugar Technologists contributed technical papers on different phases of sugar-cane culture for the convention of the society which was held on August 13, 14, and 15, 1931, at Bacolod, Occidental Negros.

The College of Agriculture was awarded a silver cup by Philippine Carnival Association—as recognition for having the most technical live stock exhibit at the 1931 Live Stock Show in Manila.

In the 1930-1931 sugar-cane breeding season, the Department of Agronomy was able to perform fourteen different crosses, out of which about 10,000 seedlings were obtained. In addition, more than 10,000 seedlings were produced by selfing the variety 2878 P. O. J. In the 1929-1930 season, about 28,000 seedlings were raised both from crosses and self-pollinations.

At meeting of the Los Baños Biological Club July 30, 1931, at 7:30 p. m., in the Lecture Hall of the Department of Agricultural Chemistry the following papers were read and discussed:

1. "Relation of leucocytes to lactation."—By Dr. Tomas T. David.
2. "Effects on the yield of grain and straw of rice by allowing weeds to decay in soil."—By Mr. Fernando Peralta.
3. "Native methods of preparing nami" (*Dioscorea hispida* Dennst.) tuber for food.—By Ranger Mamerto D. Sulit.

A letter to Dean Gonzalez from Francisco M. Sacay, B. S. A. '27, University U. P. Fellow 1928 to Cornell University contains the information that Mr. Sacay will soon return.

The degree of Ph.D. was conferred by Cornell University on Mr. Sacay June 15. The subject of his thesis which covered about 500 pages of manuscript is "A survey and evaluation of vocational education in agriculture in the Philippines."

On his way west Mr. Sacay will visit Iowa State College, at Ames, University of Wisconsin, and University of Minnesota to make a cursory study of the supervision of vocational agriculture and teacher training in those States.

The faculty of the College of Agriculture has been strengthened by the return recently of Dr. Pedro David, Instructor in Agronomy. Doctor David left the Philippines about three years ago and went to the United States as a fellow of the University of the Philippines. He specialized in agronomy in Iowa State College at Ames, and there obtained the degree of Doctor of Philosophy.

* * *

Mr. Francisco S. Gomez, B.S. in Sugar Technology '31, now employed as assistant chemist in Central Santos-Lopez, Iloilo, was a recent visitor in the Department of Agronomy. Mr. Gomez is negotiating with the Department for cuttings of a number of foreign varieties of sugar cane growing in its collection as well as of seedlings varieties produced by the College.

* * *

Mr. Geronimo Creag, B.S.A '31, with major in Agronomy, writes that he is now employed in Hacienda Cabalawan, Sagay, Occidental Negros, where sugar cane is the principal crop. He says that the *talahib* begins flowering there as early as June and that farmers in the locality claim that 2878 P.O.J. does not flower in that place.

* * *

The International Institute of Agriculture has recently published in Rome a methodological study having the object of explaining the purposes and procedures adopted in many countries in the construction of the different series of index numbers and therefore their significance. This documentation presents a scientific and practical interest to all those occupied in the study and use of index numbers of prices of interest to the agriculturist.

This publication of the International Institute of Agriculture also contains tables in which are grouped all the data available for a series of years, as far as possible from January 1921 to December 1929, concerning index-numbers of prices of agricultural products and other price-indices of interest to the farmer.

The Institute publishes periodically in its "Monthly Crop Report and Agricultural Statistics" the index-numbers which are available in many countries of the world.

* * *

"When you sit with a nice girl for two hours, you think it's only a minute, but when you sit on a hot stove for a minute, you think it's two hours. That's relativity."—ALBERT EINSTEIN.

—*What the Colleges Are Doing.*

FATHER FRANCISCO IGNACIO ALZINA, S.J.

AN AGRICULTURAL OBSERVER OF THE SEVENTEENTH CENTURY[1]

REV. MIGUEL SELGA, S.J.
Director, Weather Bureau

Among the various unpublished documents in the libraries in Manila is one written in 1668 by Father Francisco Ignacio Alzina, S.J., which deals with the natural resources, cultivation, and modes of life of the inhabitants of the Visayan Islands during those times. In the midst of his multiple missionary duties Father Alzina found time to record the habits of the natives among whom he worked, the fertility of the soil, and forest resources of mountains and valleys which he visited, and the diversity of the islands, capes, and straits that he saw. During his residence of over thirty-three years in the Visayas, he collected and handed down to posterity accounts of numerous observations of botanical, zoölogical, ethnological, and climatological interest, which, in addition to their intrinsic merit, are of particular value in that they provide points of comparison between the past and the present, whereby we may judge the changes that have taken place in the Archipelago in the two and a half centuries that have since elapsed.

Father Alzina was born in Gandia, Spain, about 1609, joined the Society of Jesus in 1624, and left Zaragoza for Manila on April 19, 1631, arriving at his destination on May 26, 1632. He stayed in Manila for about two years. He was ordained as priest on July 27, 1634. Soon after he left Manila for Borongan, Samar. He travelled and lived in some of the other Visayan Islands, although he made most of his important observations in Samar and in Leyte. During his residence in these regions, he helped the inhabitants in their needs, gave them advice on the proper conduct of their business, and showed them how to get the best out of their soil which Nature so bountifully endowed with riches. He introduced there a new variety of *bilimbin* (*Averrhoa carambola* Linn.) which was imported from Maluco and which was superior to the older forms. He divided the plants among different towns and planted them with his own hands. Speaking of *chiquios*[2], Father Alzina said: "I planted the more than one hundred plants that now grow in Visayas. The fruits are regarded as among the most delicious in the world, gold colored, and so fine and pleasing to look at and more so when ripe on the trees and set against the green of the leaves.

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[1] Translated by Leopoldo B. Uichanco from the original in Spanish. Translation verified by the author. Received for publication July 22, 1931.

[2] Probably *Achras sapota* Linn.—L. B. U.

In the judgment of not a few intelligent persons who saw and ate them, they make one wonder if they were not what tempted Eve." He introduced the method of making cigar cases and *abolotes* with light, thin sheets of wood which protect the contents from injury. He taught the natives how to weave, with colored rattan and feather of *diao*[3], cigar cases which were so neat and unique that they could be sent as gifts to the king himself. He observed in Calbiga, Samar, the nutritive value of sugar cane in a case where it was fed to a baby whose mother's breast had gone dry so she could not suckle it. He spoke in praise of the cane juice produced in Paranás, Samar, where an *intus* is made which after boiling is converted into a kind of boiled honey of Spain and having the same taste and color. He remarked on the prolificacy of corn which in Mexico seldom produced three or four ears to a plant; in the town of Calbiga he saw one plant alone producing fifteen ears, all big and full of kernels. In Palapag he planted Chinese grapes with his own hands and taught the natives to plant these in their yards and farms. The plants grew and produced so rapidly that in two years they reached the size of the fleshy part of a good-sized arm. They flowered abundantly and the grapes were so sweet and mellow that recently arrived priests pronounced them to be as good as those of Castile. By means of hooks, traps, and a thousand other contrivances, he turned his attention to the extermination of the crocodiles in the town of Pambujan, which was infested with these beasts, in whose claws and teeth many men and women had ended their days. For lack of steel balls for the small cannon which were used for defence against the pirates, he taught the inhabitants of the town how to make and use balls fashioned from a very hard wood, called *bantigi*[4]; but there was no call for their use because the enemy did not dare approach and give them a chance to try if the balls would produce swelling or break skulls without shedding blood.

Father Alzina had that very fine quality of knowing how to adapt himself with understanding to the people among whom he exercised his ministry. Many times, this virtue required the sacrifice of likes and inclinations that he had acquired since childhood. The gabis of the Bisayas tasted so fine and delicate to him that "I confess that having them I did not miss bread." When hiking in the mountains, if he did not come across a spring, "I drank several times of the water which the rattan, after cutting the stem, exuded in such quantity that there streamed out more than a *pluma*[5]. It was as clear as rain water and I could detect no difference between the two." Not a few times he made use of the bark of the cane called *cabugavan*[6] as writing paper. It was as smooth and glossy as burnished paper. He likewise received letters from other priests on similar stationery. Twice he was shipwrecked and his life was imperiled. Had the vessel had no outriggers, it would have sunk and floundered miserably.

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[3] Probably *Oriolus acrorhynchus* Vigors.—L. B. U.

[4] Probably *Pemphis acidula* Forst. (Lythraceae).—L. B. U.

[5] Pluma, a measure of running water.

[6] Probably the common spiny bamboo, *Bambusa spinosa* Roxb.—L. B. U.

Father Alzina found the meat of the monitor lizard[7] delicious food, especially on Fridays and on days of fasting. He ate it many times and found it as tender as chicken.

Following the example of other priests who made similar attempts, he tried to enclose in a small glass vial a certain number of fireflies of those kinds which produced so much light that without other illuminants one could read and write. "If we had known how to keep them alive in confinement (they died shortly after enclosing), the scheme would have been worthy of imitation and application."

Although he was of a complaisant nature with respect to many customs, Father Alzina never lowered himself to the extent of keeping silent about practices which did not appeal to his idea of honor and dignity. It is well known that *buyo* "soothes the stomach, strengthens the teeth, and sweetens the breath." However, Father Alzina severely criticized this habit of the Filipinos[8] and Spaniards here, "who bite or chew the *buyo* so that the mouth becomes ferocious, the tongue almost black and cracked, the lips red ochre in color, and everything in such bad taste that at first they give a very poor impression to new comers here from Spain. To one who eats *buyo* and later on chews tobacco, serious harm may happen. I have not tried either one or the other during my more than thirty-four years of residence in these Islands and in my more than thirty-two years of life among the Filipinos."

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[7] Iguana in the original; obviously a misnomer. Many Europeans and Americans still persist in calling our monitor lizard, *Varanus salvator* (Laurenti), an iguana.—L. B. U.

[8] "Indios" in the original.—L. B. U.

It is ridiculous to speak of unemployment as a necessary condition of human society. It is nothing more than a maladjustment of its machinery. It is a blot on our intelligence. It is a drain on our sympathy. It is a promoter of charity which affects disadvantageously both those who give and those who receive. Some day we shall learn to do better, but we must learn it soon.—OWEN D. YOUNG.

—*The Review of Reviews,* February, 1931.

TWO DISEASES CAUSED BY DIPLODIA[1]

F. L. STEVENS AND M. S. CELINO
Of the Department of Plant Pathology

WITH TWO PLATES AND TWO TEXT FIGURES

LEAF SPOT OF CORN CAUSED BY DIPLODIA MACROSPORA EARLE

A leaf disease of corn in which the spot is up to 9 centimeters or more long and one or more centimeters wide, bordered by a brown band a millimeter wide, which in turn is surrounded by a yellowed region a millimeter wide is seen quite frequently in the vicinity of Los Baños (pl. I). The body of the spot is tan-colored and dead and shows numerous scattered pycnidia.

The pycnidia are dark brown, 180-260 μ in diameter, immersed, and remaining covered, only the ostiole protruding through the epidermis. The ostiole is bordered by a narrow black ring and opens both hypophyllous and epiphyllous (fig. 1). The spores are dark brown, elongate, usually 1-septate, rarely 2-septate, obtuse at each end, 45-80 × 9 μ, septum usually median, but sometimes nearer to one end of the spore.

The disease except for the occurrence of pycnidia instead of conidiophores bears a striking resemblance to the Helminthosporium leaf blight for which it may readily be mistaken.

Four species of *Diplodia* are recorded on *Zea mays* L.:

1. *Diplodia maydis* (Berk.) Sacc. originally described as *Sphaeria maydis* in 1847, on corn culms. It has elliptical-cylindrical spores, 25-30 × 6 μ.

2. *Diplodia frumenti* Ell. and Evht. described in 1886 on culms. Its spores are even shorter than those of the last.

3. *Diplodia? maydicola* Speg. Spores, 24-26 μ long. It is obvious that each of these three species differs materially from our specimen.

4. *Diplodia macrospora* Earle on corn culms, however, agrees well with ours except that Earle gives the spores as 70-80 μ long and often biguttulate, while in our specimen we do not find the spores guttulate and their minimum length is much less than that mentioned by Earle. These differences are, however, so slight that we regard our fungus as *D. macrospora* Earle, though he did not mention its occurrence on leaves.

This is the first report of this disease anywhere and the first report of this fungus in the Philippines.

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[1] Experiment Station contribution No. 749. Received for publication December 12, 1930.

A DIPLODIA ROT OF LUFFA

A soft watery rot of the pericarp of *Luffa acutangula* (L.) Roxb. and *L. cylindrica* (L.) M. Roem. was found in several different localities near Los Baños. It attacks fruits of various ages from very young to quite old and progresses very rapidly through the host tissue, advancing as much as five centimeters in 24 hours (pl. II). When the spot is young or in the young region of an old spot the appearance is merely that of a soft and watery region with a rather definite border.

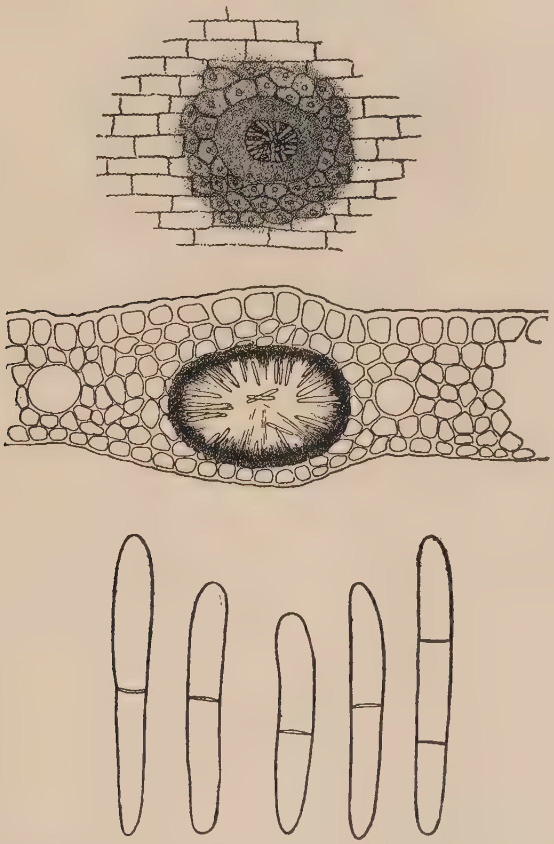

Fig. 1.—*Diplodia macrospora* Earle showing pycnidia and spores.

In regions of the spot four days old, exceedingly numerous pustules, young pycnidia, appear. About ten days after invasion by the fungus the pycnidia are well developed and black.

Microscopic examination of the newly invaded host tissue reveals an abundance of mycelium. The young pycnidia bear oval, one-celled, hyaline, large spores as in the genus *Macrophoma*. Later, these spores turn dark but still remain continuous as in the genus *Sphaeropsis*. Still later, the spores all become one-septate, finally placing the fungus in the genus *Diplodia*. The examination of immature material would lead to error in the classification of the fungus.

The fungus was isolated in pure culture on November 5, 1930 from diseased *Luffa acutangula*. It grew well and produced abundant mycelium in various agar media.

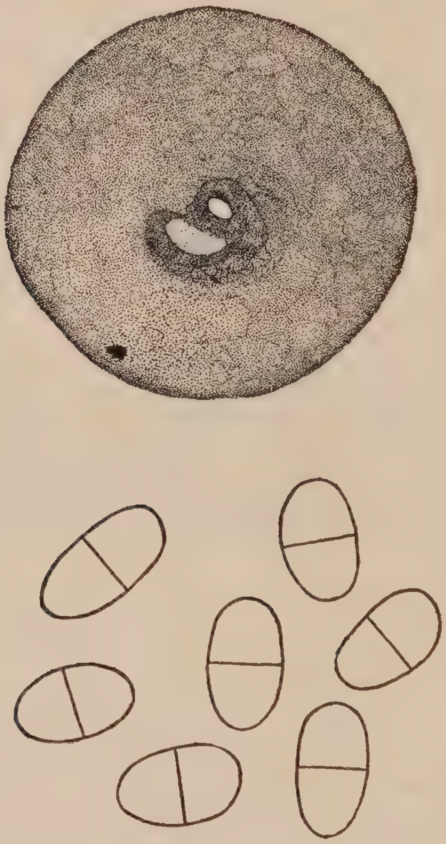

Fig. 2.—*Diplodia adelinensis*, a pycnidium and spores.

Inoculation experiments were performed on November 11, 1930, both in the field and in the laboratory. Inoculation was done by making a small injury on the normal fruits of *L. cylindrica* and putting in these injured parts bits of agar containing the fungous mycelium. Small pieces of sterile potato dextrose agar were placed on the controls. The fruits treated in the laboratory were kept inside the damp chamber for 48 hours. On the third day small watery discolored spots were noted on the inoculated fruits. Two days after that the spots were very conspicuous. Infection advanced very rapidly. On the fourth day a considerable portion of the inoculated fruits appeared rotted, and on the surface young pycnidia were seen.

The fungus was easily recovered by reisolation. Reinoculation proved conclusively the pathogenicity of the organism.

Since the fungus is new we propose the following name and description. The name is in honor of Adeline Chapman Stevens in recognition of the great assistance she has rendered to the senior author in his botanical studies through many years.

Diplodia adelinensis **Stevens and Celino, sp. nov.** Pycnidia when mature densely black, 150-200 μ in diameter, ostiole 30 μ across, reticulatious about 11 μ across. Spores ovoid, sometimes irregular or inequilateral, black, 18-24×14 μ, 1-septate, surface very minutely echinulate, mycelium hyaline, septate.

On *Luffa acutangula*
Agricultural College, Laguna, P. I.
November 4, 1930, Stevens, No. 1030
By inoculation on *Luffa cylindrica*
Stevens, No. 1033

This species possesses spores of the size most common in the genus *Diplodia*, but is quite distinctive in the echinulation of the spores. The fact that the immature hyaline spores are larger than the mature dark spores is mentioned also for *D. ramulicola* Desm.

Host range. In order to determine the host range of the fungus other fruits were inoculated with it on November 14, 1930. The parasite did not prove pathogenic on tomato (*Lycopersicum esculentum* Mill), eggplant (*Solanum melongena* L.), papaya (*Carica papaya* L.), squash (*Cucurbita maxima* Duch.), pepper (*Capsicum annuum* L.), and upo (*Lagenaria leucantha* (Duch.) Rusby.

LEGEND FOR PLATES

PLATE I

Diplodia macrospora Earle on corn (*Zea mays*), somewhat enlarged and showing pycnidia in the lesion.

PLATE II

Diplodia adelinensis on *Luffa cylindrica*, right and on *L. acutangula*, left.

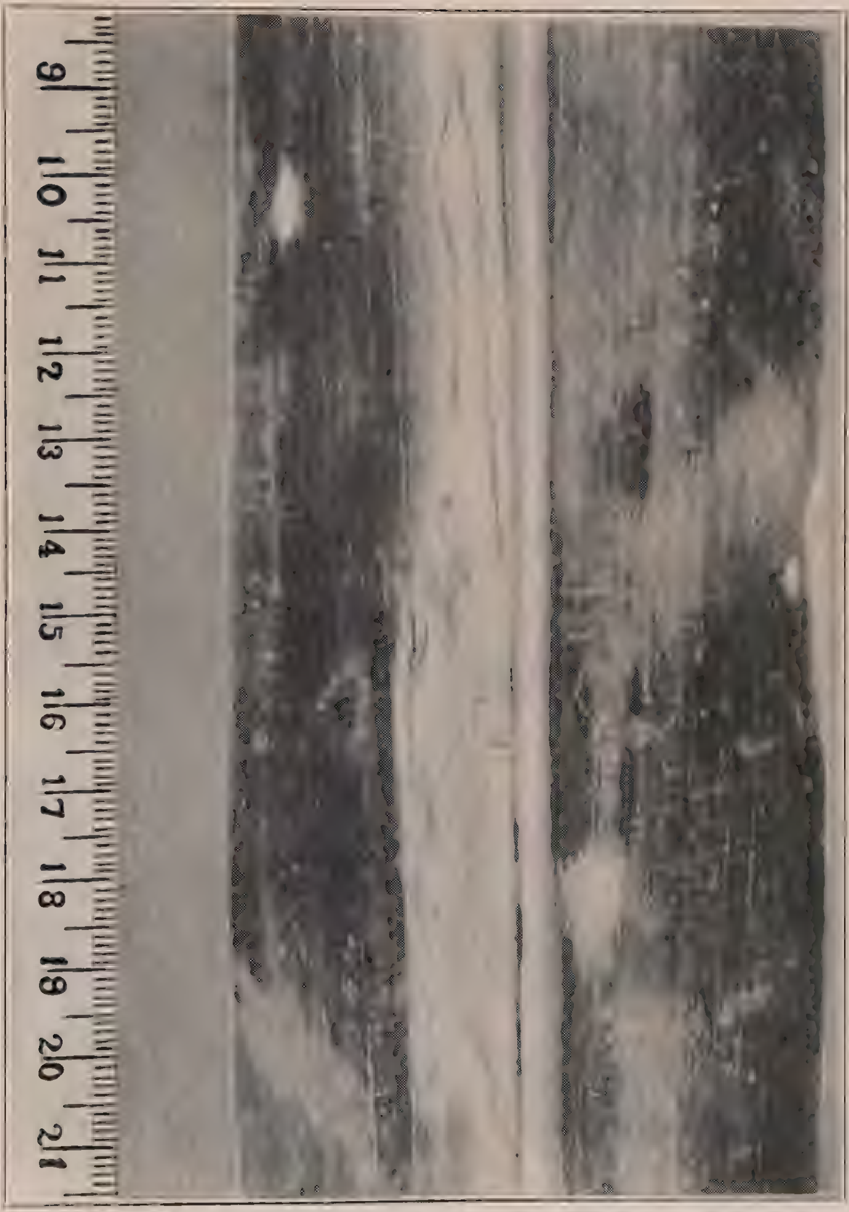
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PLATE I

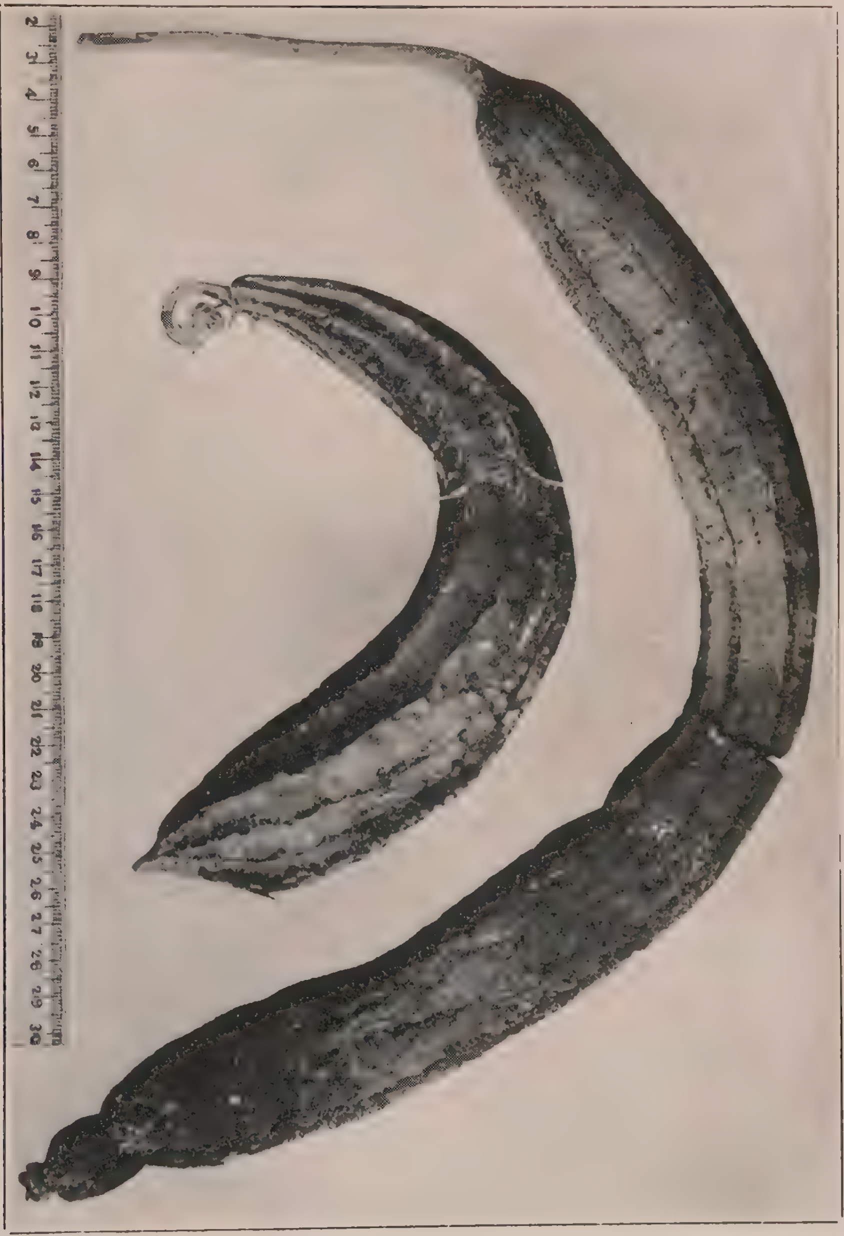
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PLATE II

JAVA SELECTED HEVEA CLONS SUCCESSFULLY INTRODUCED IN THE COLLEGE OF AGRICULTURE[1]

N. B. MENDIOLA
Of the Department of Agronomy

WITH EIGHT TEXT FIGURES

It was very early recognized in the Dutch East Indies as well as in other countries growing the Para rubber plant (*Hevea brasiliensis* HBK) that to lower the cost of production of Hevea latex and to obtain more profit in Hevea culture it is necessary for Hevea planters to grow trees which are superior in yield and resistance to disease and are desirable in other respects. For this reason the work of selecting such trees and propagating them by budding into pedigree clons was started early in Java and Sumatra not only by the government but also by associations of Hevea growers. The branch of the Java government in charge of this work is the General Experiment Station for Agriculture.

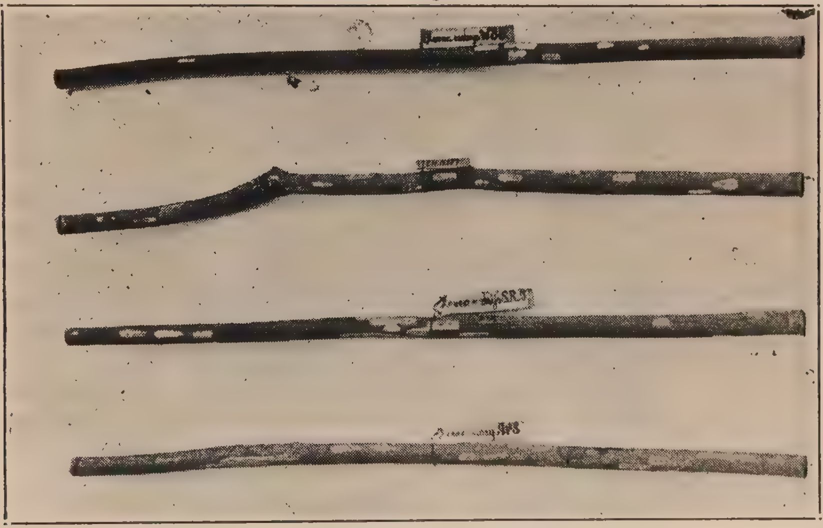

Fig. 1.—Original bud sticks of Ct. 88, Ct. 3, Ct. 5 and Ct. 9 which were imported from Java. Trees from buds of Ct. 3 and Ct. 88 are now growing in the College of Agriculture.

After many years of careful and continuous work the Java Experiment Station, particularly through its noted director, Dr. P. J. S. Cramer, was

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[1] Experiment Station contribution No. 751. Received for publication July 15, 1931.

able to isolate and subsequently propagate several very superior strains of the Para rubber species. Among these strains are those bearing the pedigree designations Ct. 3, Ct. 5, Ct. 9 and Ct. 88. (Ct. stands for Cultuurtuin, which means the Economic Garden of the General Experiment Station. Similarly in Sumatra the A. V. R. O. S. have isolated clons designated as Avros—31, 33, 35, 36, 49, 50, 52, 80, 147, 152 and 163.

Through the kindness of Doctor Cramer and his friendly courtesy as well as that of his colleagues in the Station to the College of Agriculture at Los Baños, the writer was able to secure a meter of budwood of each of the cultuurtuin selected strains, (see fig. 1.) and two budded stumps of Ct. 88 and of Ct. 2. These valuable materials were brought by the writer from Buitenzorg, Java, to Los Baños, Philippines where they arrived on August 23, 1927. The plants were planted near Cottage 5 on the Faculty Hill and the buds were inserted on stocks growing in a rubber plantation of the Philippine School of Forestry.

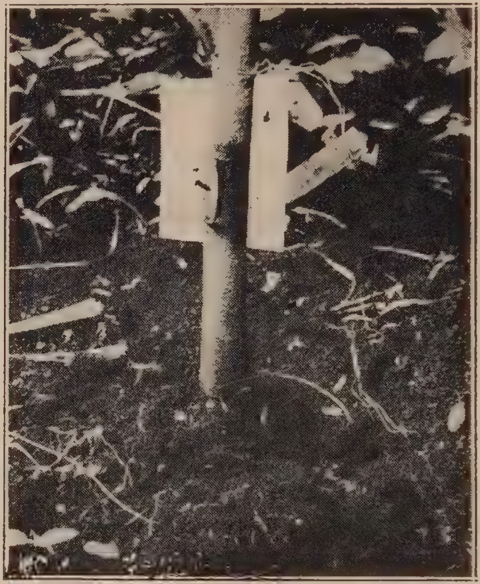

Fig. 2.—A Ct. 3 bud developing on stock No. 2604-41. Photographed November 12, 1927, or about two and one-half months after insertion of the bud.

It is the object of the present paper to present a report on the work of budding performed with the imported buds and on the general growth of the plants which were brought from Java and of those obtained from the buds.

The work and observation embodied in this report cover a period of nearly four years, extending from the day of the arrival of the imported materials, August 23, 1927 to July, 1931.

MATERIALS AND METHODS

Strains under report. The subjects of this report are Para rubber strains Nos. Ct. 88, Ct. 3, Ct. 5 and Ct. 9. Of these strains Ct. 88 is the best. It originated as a seedling of Ct. 3. According to careful records made of the yield in Java of a clon of Ct. 8, this strain yielded in its eighth year of life an average of 2500 grams of rubber per tree tapped one-third of the circumference at 50 centimeters above the line of union of stock and scion. Because of this high yield this selected strain is supposed to be the one most widely grown in Java and is used by the Central Rubber Experiment Station of that country as the standard for comparison with other strains. Besides high yield, other characteristics of this clon are uniform growth and production and heavy branching. Also the bud separates easily from the wood, a thing which is very desirable in the budding operation. A meter of budwood of this strain gives about twenty usable buds.

Ct. 3, Ct. 5, and Ct. 9 while better producers than the average are not as excellent yielders as Ct. 88.

Importation of the strains. The budwood of the different strains imported was prepared and packed according to a method which the General Agricultural Experiment Station of Java was experimenting with and which the writer would not describe publicly or in a paper without the permission of that Station. Each bud stick was one meter long and each was cut from its respective mother tree on August 4, 1927. On August 23 of the same year, the materials arrived at Los Baños and two days after, or 21 days after the budwood was cut from the mother trees, the buds were inserted in Hevea stocks belonging to the School of Forestry.

There were imported two budded stumps each of Ct. 88, and Ct. 2. These stumps were transported in a Wardian case and upon arrival at the College were planted near Cottage No. 5 on Faculty Hill.

The budding operation. The rubber seedlings which were used as stocks in the budding operation were in School of Forestry Lot No. 2604, Hectare 6-A. This lot has an elevation of about 80 meters above sea level. On the day the buds were inserted in the stocks, they were about one year and eleven months old. At this age they had stems two and one-half to three centimeters in diameter at the point of insertion, which was about eight centimeters above the ground. The method of budding used is known as patch budding.

There were inserted 25 buds of Ct. 3, 24 of Ct. 5, 4 of Ct. 9 and 19 of Ct. 88.

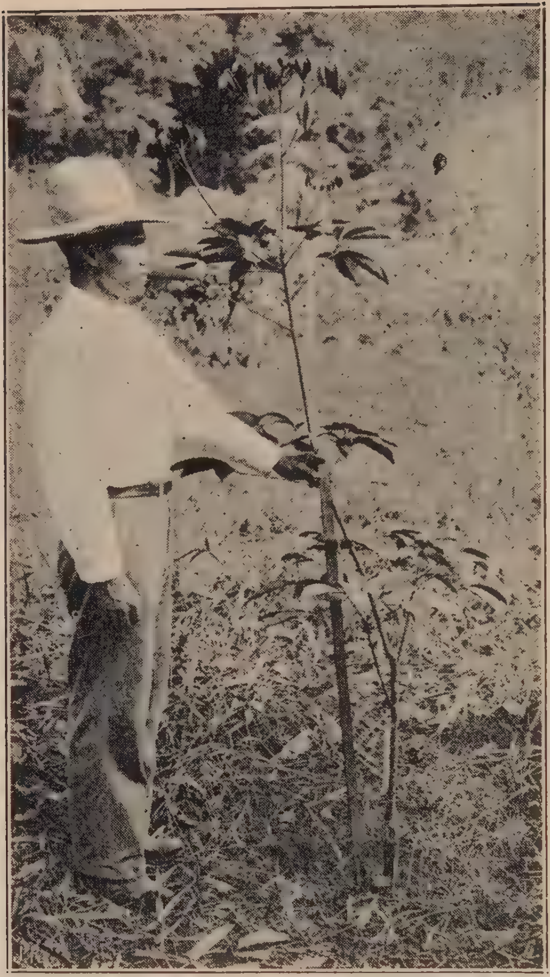

Fig. 3.—Ct. 3 on stock No. 2604-41. The plant was from the bud shown in figure 2. Photographed September 14, 1928, when the scion was a little over one year old.

Two weeks after the buds were inserted, the number remaining fresh was recorded. Measurement of height of the resulting budded plants was made subsequently when they were about 2 years, 3 years, and 3 years and 10½ months old.

RESULTS

Most of the statistical results of the experiments herein reported are given in tables 1 to 4.

TABLE 1

Percentage of success observed two weeks after budding[a]

CLON NO.	NUMBER OF BUDS INSERTED	BUDS REMAINING FRESH	PERCENTAGE OF FRESH BUDS
Ct. 3	19	9	47
Ct. 5	22	14	64
Ct. 9	4	0	0
Ct. 88	17	12	70
Total	62	35	

[a] The bud sticks were 21 days old.

TABLE 2

Diameter and branches of budded trees at age of three years

STOCK NO.	CLON NO.	NO. OF[a] BRANCHES	BUD STICKS AVAILABLE IN 1930
			m
2604–41	Ct. 3	7	14
2604–63	Ct. 5	12	24
2604–93	Ct. 5	13	26
2604–113	Ct. 88	5	10
2604–141	Ct. 88	2	4
2604–163	Ct. 88	6	12

[a] Only branches having a diameter of 3 centimeters or more were included.

TABLE 3

Growth of budded rubber plants

STOCK NO.	CLON NO.	LENGTH OF SCION ON NOV. 12, 1927	HEIGHT AT AGE OF 2 YEARS	AT AGE OF 3 YEARS		AT AGE OF 3 YEARS AND 10½ MONTHS	
				Height	Diameter one meter above ground	Height	Diameter one meter above ground
		cm.	cm.	cm.	cm.	cm.	cm.
2604–41	Ct. 3	1.00	354	750	4.30	760[c]	7.48
2604–63	Ct. 5	15.00	413	730	5.51	dead	——
2604–93	Ct. 5	17.50	308	630	3.67	dead	——
2604–113	Ct. 88	30.50	283	470	5.40	775	7.64
2604–141	Ct. 88[a]	1.50	113	100	1.97	dead	——
2604–163	Ct. 88[b]	30.50	176	350	3.04	605	5.79

[a] Cut accidentally before July 30, 1930.

[b] Two shoots developed and originated from the inserted bud, but one of them died subsequently.

[c] Top of stem cut previous to measurement.

TABLE 4

Growth of budded rubber plants and of the lot to which the stocks belong[a]

STOCK NO.	CLON NO. OF SCION	1927[b]		1928		1929		1930		1931		AVERAGE ANNUAL INDIVIDUAL GROWTH	
		Dia.[c]	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.
		cm.	*m.*	*cm.*	*m.*	*cm.*	*m.*	*cm.*	*m.*	*cm.*	*m.*	*cm.*	*m.*
2604–41........	Ct. 3	—	—	—	1.92	2.5	2.4	4.0	5.0	6.3	6.4	1.26	1.12
2604–63........	Ct. 5	—	—	—	3.07	3.7	4.5	5.7	6.0	8.2	7.3	1.50	1.06
2604–93........	Ct. 5	—	—	—	2.15	2.5	2.5	3.7	4.2	5.2	5.7	0.30	0.89
2604–113.......	Ct. 88	—	—	—	2.00	3.6	2.6	4.0	4.0	6.3	6.0	0.90	1.00
2604–141.......	Ct. 88	—	—	—	0.80	3.0	0.9	—	—	3.8	1.0	0.27	0.05
2604–163.......	Ct. 88	—	—	—	1.70	2.6	1.8	2.6	3.0	4.9	4.3	0.77	0.55
Entire lot.....	....	—	1.24	—	2.15	2.02	2.46	3.05	3.61	4.70	5.24		

[a] Data furnished by School of Forestry.,

[b] Measurement taken either in April or in May of the year.

[c] Taken at breast height of the stem.

Table 1 shows the number of buds which were found green two weeks after they were inserted in the stocks. Table 2 gives the number of branches produced by the budded trees at the age of three years. Table 3 gives the height and diameter of the budded rubber plants at the ages of two years, three years, and three years and ten and one-half months counting from the day the budding was done. Table 4, furnished by the School of Forestry, gives the growth of the budded plants as compared with the entire lot to which the stocks belong. The data in table 4 serve to check and confirm those in table 3.

The two budded stumps of Ct. 2 and one of Ct. 8 planted near Cottage No. 5 on the Faculty Hill died a few months after transplanting. The other plant of Ct. 8 is still living. Its life, however, was threatened in the summer of 1931 when it was attacked by a die-back disease. The summer of 1931 was unusually dry and hot and probably partly for this reason this Ct. 88 plant shed all its leaves after which it was in flush all over and flowered for the first time. It was at this stage that the terminal flush was attacked by a die-back disease which quickly moved downward reaching the flush of the preceding year. By pruning below the boundary of the diseased portion of the stem, then painting the wood with asphaltum, the plant was saved. At the time it was attacked by the die-back, it had reached a height of 3.79 meters and had a stem diameter at a point one meter from the ground of 4.5 centimeters.

On December 27, 1927, it was found that Ct. 5 on stock No. 2604-91 had died. On July 30, 1930, it was discovered that Ct. 88 on stock No.

2604-141 had been cut some time previously and two shoots had formed on the scion. On April 2, 1931, a fire, which originated on a *caingin* near Forestry Lot 2604 on which the budded clons are, reached several of the budded trees killing Ct. 5 on stock No. 2604-63, Ct. 5 on stock No. 2604-93 and Ct. 88 on stock No. 2604-141. Ct. 88 on stock No. 2604-113 was also partly burned but it is recovering, gradually.

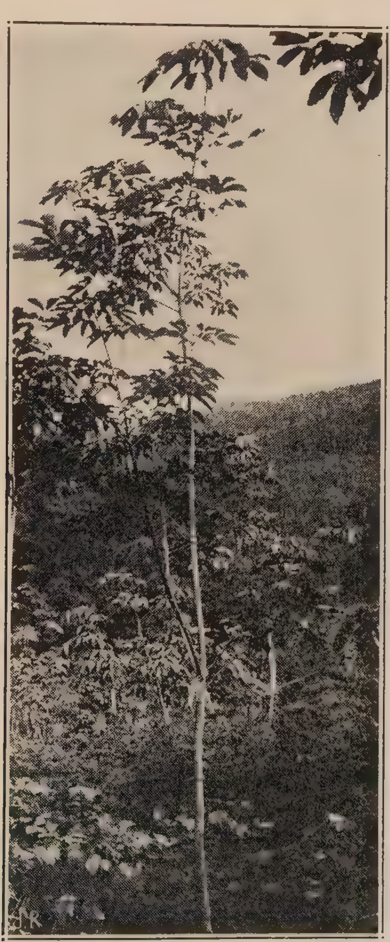

Fig. 4.—Ct. 3 on stock No. 2604-41. The plant was from the bud shown in figure 2. Photographed September 1, 1930, when the scion was about three years old.

At the present writing, of the clons introduced in 1927, there are living only one plant of Ct. 3, growing on stock No. 2604-41, two budded plants of Ct. 88 on stocks Nos. 2604-113 and 2604-163 and one plant of Ct. 88 introduced as a budded stump.

To insure these two remaining clons against total loss from accidents or possible death on account of disease or pests, buds from Ct. 3 and from Ct. 88 have been inserted on stocks belonging to the College of Agriculture. With these last budding operations it might be said that these two clons have passed the critical stages of the introduction and only a catastrophe can wipe out their existence in this country and prevent their propagation in the future.

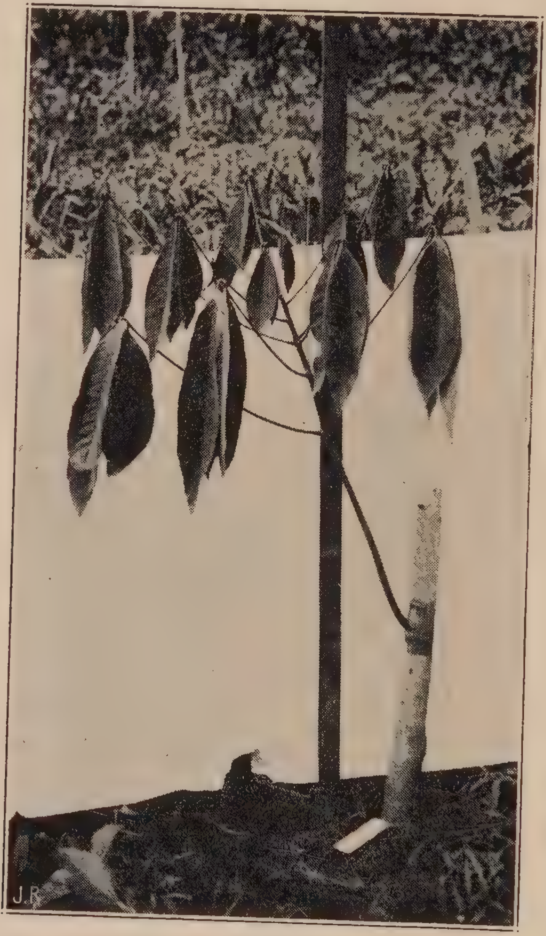

Fig. 5.—Ct. 88 on stock No. 2604-113. Photographed November 21, 1927, when the scion was about 3 months old.

DISCUSSION OF RESULTS

Factors responsible for the successful introduction of the Java selected Hevea clons Ct. 88 and Ct. 3. One of the most important of these factors was the method by which the budwood was packed for shipment from Buitenzorg, Java to Los Baños, Philippines. The buds were not used until 21 days after the budwood was cut from the trees, but in spite of this length of time, successful buddings were obtained from the wood.

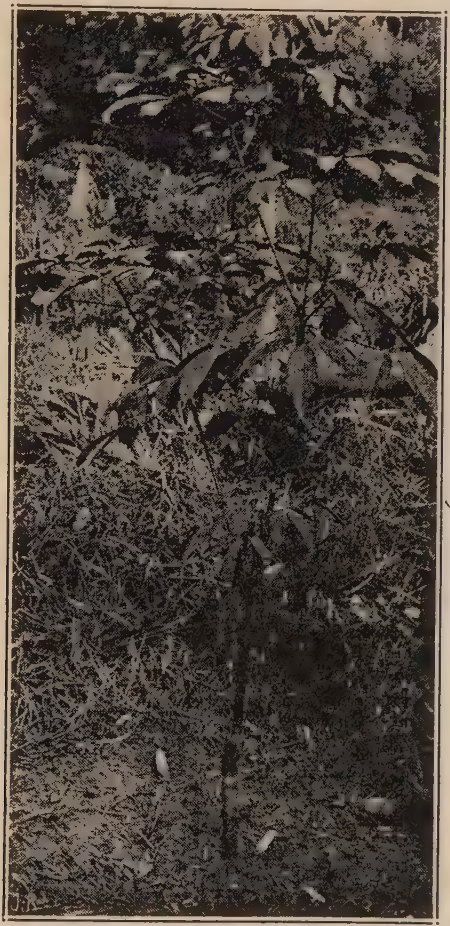

Fig. 6.—Ct. 88 on stock No. 2604-113. Photographed August 18, 1928, when the scion was about one year old.

Comparing clons Ct. 3, Ct. 5, Ct. 9 and Ct. 88, it is evident from the figures given in table 1 that the imported one meter of budwood of each of clons Ct. 3, Ct. 5 and Ct. 88 produced about the same number (20) of use-able buds while Ct. 9 gave only 4 buds. Table 2 shows that the scions which finally developed varied greatly in length and subsequent rates of growth. The success or failure of an introduction similar to the one under discussion evidently depends partly on how a clon stands in regard to the two variations just pointed out. Success is more easily obtained with a clon which gives several usable buds even after a long transit and the buds of which grow fast, than with a clon giving fewer and more slow growing buds. To the latter class belongs clon Ct. 9. The imported budwood of this clon gave only four usable buds, hence the unsuccessful result of its introduction is not surprising.

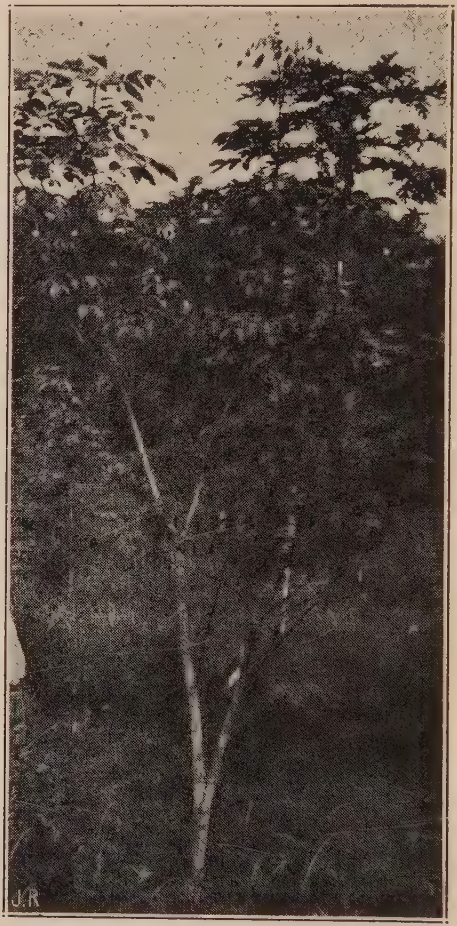

Fig. 7.—Ct. 88 on stock No. 2604-163. Photographed September 1, 1930, when the scion was about three years old.

Subsequent experience in budding has taught the writer that a higher percentage of success in budding is obtained during the wet season than during summer, or dry season. It was fortunate that the budwood from Java arrived in this College during the rainy season; otherwise, the effort at introduction might have been a total failure.

Factors which tended to minimize the success of the introduction. Besides the points noted in preceding paragraphs, there should be mentioned the accidental cutting of budded plant Ct. 88 on stock 2604-163 and the fire which killed the two surviving plants of Ct. 5 on April 2, 1931. At the time of this accident one of the two plants was more than 5 meters high and the other more than 7. Had this accident not occurred, there would have been three instead of only two clons surviving at the present time. In a similar work in the future, precautions could be taken against such accidents.

Growth of the buds and budded plants. (See fig. 2 to 7.) Table 3 shows that at the age of two years, the budded plants had reached a height of from 1.76 to 4.13 meters; at the age of three years, 3.50 to 7.50 meters; and at the age of three years and ten and one-half months, 6.05 to. 7.60 meters. The height of Ct. 88 on stock 2604-141 was not taken into consideration because of the accidental pruning which it suffered in 1930. The measurements given in table 4 performed by the School of Forestry confirm those in table 3. They further show that the imported buds caught up in growth with the other rubber plants in the lot to which the stocks belong.

Of greater interest from the point of view of introduction and propagation of the clons under report is the amount of budwood available on each plant at the age of three years as shown in table 2. At this age each plant had from 5 to 13 branches all of which were possible sources of buds. The plants could have been pruned at this age and even earlier for purposes of vegetative propagation but propagation was purposely delayed about a year in order to insure a greater number of buds. Where there is danger of accidents which might kill the plants, it would be better to propagate the plants as early as possible.

SUMMARY

On August 23, 1927, the writer brought with him from the General Agricultural Experiment Station of Java, a meter of budwood of Java selected Hevea clons Ct. 3, Ct. 5, Ct. 9 and Ct. 88 and two budded stumps of each of clons Ct. 2 and Ct. 88. Two days after arrival in this College, or 21 days after the budwood was cut from the mother trees, buds were taken from the budwood and inserted on stocks about one year and eleven months old and with a diameter of two and one-half to three centimeters at a height of about eight centimeters from the ground. There were secured from the budwood and inserted in stocks twenty-five buds of Ct. 3, twenty-four of Ct. 5, four of Ct. 9, and nineteen of Ct. 88. The budded stumps of Ct. 2 and Ct. 88 were planted near Cottage 5 on Faculty Hill. Of these only one plant of Ct. 88 survived (see fig. 8).

None of the four buds of Ct. 9 grew. Of the other clons, one plant was grown finally from Ct. 3, two plants from Ct. 5 and three from Ct. 88. At the age of two years, the budded plants reached a height of from 1.76 to 4.13 meters; at the age of three years, 3.50 to 7.50 meters; and at the age of three years and ten and one-half months, 6.05 to 7.60 meters. The dia-

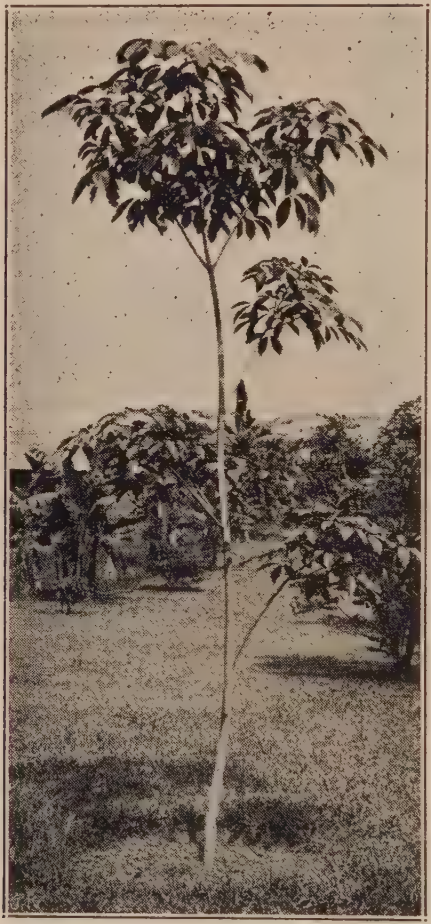

Fig. 8.—A Ct. 88 Hevea tree grown from budded stump imported from Java. Photographed September 1, 1930. The scion was a little over three years old.

meter at the last two ages was 3.04 to 5.51 centimeters and 5.79 to 7.48 centimeters, respectively. A fire killed the two plants of Ct. 5 and one plant of Ct. 88.

At the present writing, therefore, only two out of the five clons introduced are living; namely, Ct. 3 and Ct. 88. Numerous buds have been taken from these surviving plants and inserted in stocks in the rubber plantation of the College of Agriculture. With this last operation and continuous propagation in the future, it is believed the existence of these two clons in the Philippines is insured.

ACKNOWLEDGEMENT

The author wishes to acknowledge the valuable assistance given by Mr. Toribio Mercado of the Agronomy Department in the prosecution of the work reported in this paper and to thank the School of Forestry for the permission given the writer to use a number of their rubber plants as stocks and for furnishing the data in table 4.

THE POULTRY INDUSTRY OF CEBU[1]

F. M. FRONDA
Of the Department of Animal Husbandry

WITH SIX TEXT FIGURES

For some years now, the bulk of the chickens sold in the Manila markets have been coming from the provinces of Cebu, Pangasinan and Batangas. Of these three provinces, Cebu probably supplies about 50 per cent of the total number of chickens that are sold in two of the largest markets in Manila, Divisoria and Quinta. Pangasinan and Batangas each supplies about 20 per cent of the chickens sold in these markets and the remaining 10 per cent come from other provinces.[2]

At first glance, it would seem that the number of chickens estimated as coming from Cebu is somewhat exaggerated. As a matter of fact it is, for the retailers in Manila call all chickens that come from the Visayan Islands "Cebu" chickens, although not all come from Cebu Province. From information received from the wholesalers of "Cebu" chickens, the province of Bohol also contributes a quota of these "Cebu" fowls. But so large a proportion of the chickens known in the market as "Cebu" comes from that province as to make a study of the poultry industry of Cebu worth while and timely.

Among the questions that any one interested in this branch of the agricultural industries in the province of Cebu usually asks are the following: What are the conditions in Cebu that favor the raising of chickens on a scale that makes the exportation of such large numbers possible? How are these chickens raised and how are they collected from the producers? How do the wholesalers handle these chickens preparatory to shipping them to Manila? Are there any means by which the present methods may be improved so as to further promote this thriving business in the Visayan provinces?

With these questions and a few other minor ones in mind, a special trip to Cebu was made. The time spent in the province was from May 23 to 30, 1931. The observations here reported were made directly in the province and most of the data included in this report were obtained direct from individuals engaged in the buying and marketing of poultry in Cebu.

The places visited in Cebu are indicated in the accompanying map of the province. (See fig. 1.)

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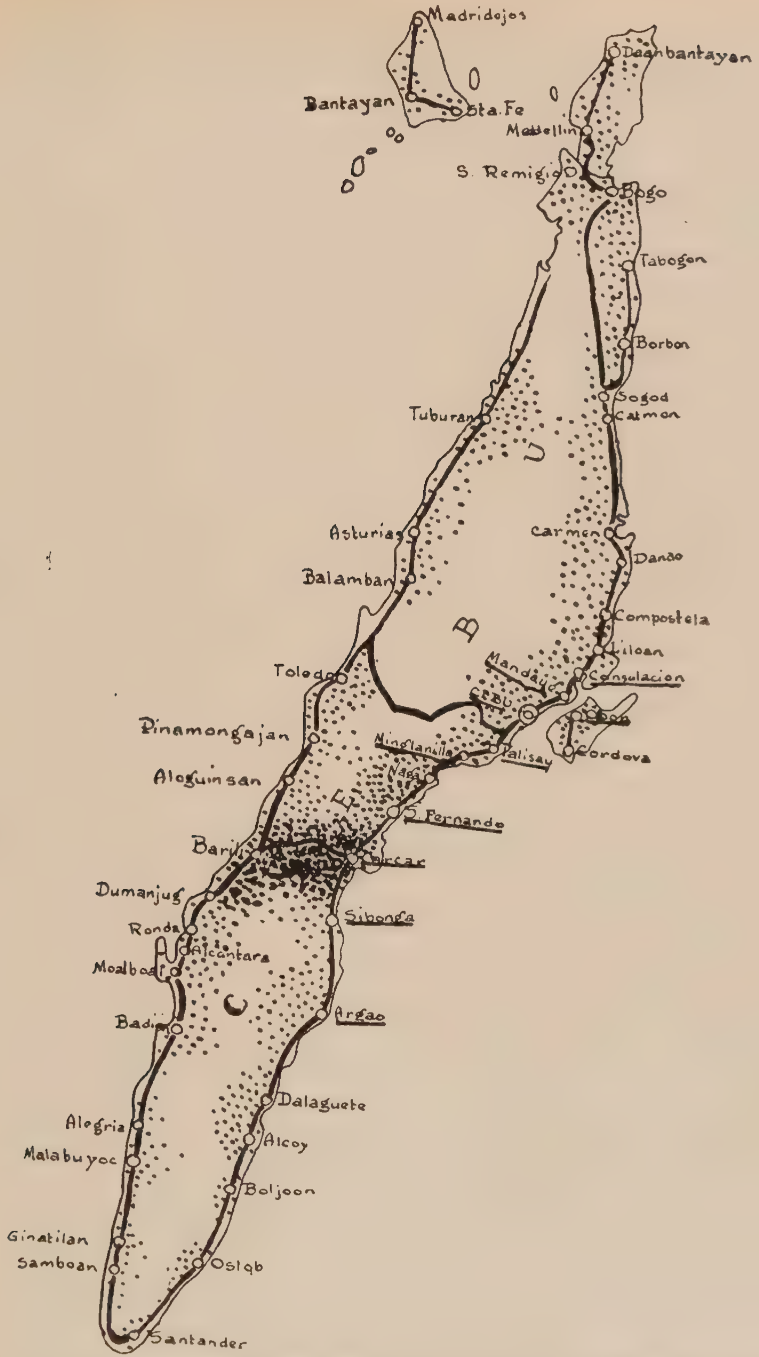
[1] Experiment Station contribution No. 752. Received for publication August 11, 1931.

The writer acknowledges the courteous help of Mr. Gerónimo Miñano of the Bureau of Animal Industry who accompanied him on all the trips made in the province of Cebu.

[2] Percentages were estimated from information received from the vendors of chickens in the Divisoria and Quinta markets, City of Manila, May 9, 1931.


Madridejos
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Bantayan
Sta. Fe
Medellin
S. Remigio
Bogo
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Borbon
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Asturias
Carmen
Danao
Balamban
Compostela
Liloan
Mandaue
Consolacion
Toledo
CEBU
Opon
Cordova
Pinamongajan
Minglanilla
Talisay
Aloguinsan
Naga
S. Fernando
Barili
Carcar
Dumanjug
Sibonga
Ronda
Alcantara
Moalboal
Badian
Argao
Dalaguete
Alegria
Alcoy
Malabuyoc
Boljoon
Ginatilan
Samboan
Oslob
Santander

Fig. 1.—A map of the province of Cebu showing the location of the different municipalities and the distribution of the poultry population of the province in 1918. Each dot represents about 1,000 fowls. The places visited in Cebu are underlined.

Location and climate. The province of Cebu comprises mainly a long, narrow island located about the center of the group of the Visayan Islands. To the east of Cebu lie the islands of Leyte and Bohol. The south is protected by the island of Mindanao and part of the island of Negros which also protects Cebu the entire length of its western coast. In the north lie Masbate and the northern part of the island of Leyte. According to the climate map of the Philippines published by the Bureau of Coast and Geodetic Survey in 1925, Cebu possesses a mild climate, with no pronounced maximum rain period and no prolonged dry season, a condition that is highly favorable for the raising of poultry.

Topography. The island is hilly and mountainous. The soil is sandy loam and along the shores it is clay loam. It is mixed in general with rocks which are made up mostly of white limestone and coral formations. The soil is loose and because of the rolling contour of the land, it is very easily drained. The excellent location, the favorable topography and soil conditions and the mild climate of the island are factors that make it ideally suited to the raising of poultry. Add to these, the excellent roads in the province and the consequent easy transportation, conditions, which, no doubt, have helped greatly in the development of the poultry industry of Cebu to its present level.

Population. The 1918 Census Reports of the Philippines recorded that the total population of Cebu during that year was 855,065. With a total area of only 483,553 hectares of which only 128,819 were then cultivated, the population of Cebu then was about 1.6 to the hectare and the specific population of the province, that is, population to the cultivated hectare, was about 7, showing that the province was one of the most thickly populated in the Islands, even thirteen years ago. From the opinions expressed by a few responsible persons interviewed, the population of the province of Cebu at present is probably much more than that reported in 1918. This claim is supported by the fact that even on the mountains are numerous dwellings and every cultivable part of the island is occupied, be it on the tops or sides of the mountains, or in the valleys. As a result of this very rapid increase in the number of people living in the province, the mountains have been deforested and made into *caiñgins* and planted to corn, the staple food crop of the people of the island. Incidentally, this makes reforestation of these denuded mountains one of the principal problems of Cebu at present.

Here, again, is perhaps a contributory factor to the present state of the poultry industry of Cebu. It is a well known tendency that the denser the population of a country, the greater will be the small domestic animal population, especially poultry, which can depend wholly upon the by-products of the manufacture of food commodities for human consumption. Poultry adapts itself readily to conditions that are found on farms and in barrios and towns where the large domestic animals can not be raised in large numbers. And in crowded places in towns where it is next to impossible to raise any of the large domestic animals, poultry can be raised in sufficiently large numbers to supply the needs of the family and have some extra available for sale.

Crops. As stated elsewhere in this paper, corn is the staple food crop of the people of Cebu. The corn raised is of the White Flint variety. The other major crops raised are coconuts, sugar cane, tobacco and to some extent maguey. Comparatively little rice is grown, and in the markets the proportion of vendors of corn to vendors of rice is probably 10 to 1. Most of the rice eaten in Cebu is imported from Manila.

In the preparation by mills of corn for human consumption, a by-product composed mostly of corn bran, corn germ and much starch is produced. Corn mills may be found almost everywhere, even in the business center of the city of Cebu, and this by-product, locally known as *tahup*, is as common in Cebu as rice bran is in the rice growing provinces in Luzon. Needless to say, rice bran is very scarce in the province of Cebu, and the poultry raisers have to depend entirely upon this corn by-product, *tahup*, for feed for their poultry.

To a large extent, the present condition of the Cebu poultry industry has probably been aided by this local food product. For its more efficient use as poultry feed, however, it should be supplemented with proteins of animal origin. To find the supplement that should be added to obtain the best results from the feeding will require some experimentation. The finding of a good supplement is one of the immediate needs, if the poultry business of Cebu is to be improved and developed further.

Stock. The poultry population of Cebu as given in the 1918 Census Reports of the Philippine Islands, was 1,009,973. Thus, the specific poultry population of the province in 1918 was about 8. Poultry was distributed among the different municipalities as follows: (See also fig. 1.)

TABLE 1

Showing the distribution of poultry in the province of Cebu in 1918

Municipality	*Number*	*Municipality*	*Number*
Alcántara	8,801	Madridejos	2,798
Alcoy	5,529	Malabuyoc	13,935
Alegría	6,152	Mandaue	18,987
Aloguinsan	22,639	Medellin	20,221
Argao	47,763	Minglanilla	12,966
Asturias	21,779	Moalbual	12,603
Badian	15,704	Naga	35,681
Balamban	14,320	Opon	15,166
Bantayan	12,392	Oslob	12,570
Barili	68,935	Pinamungahan	23,476
Bogo	29,897	Poro	11,000
Boljo-on	8,898	Ronda	11,455
Borbon	19,797	Samboan	8,453
Carcar	83,432	San Fernando	38,523
Carmen	17,880	San Francisco	18,418
Catmon	25,077	San Remigio	12,599
Cebu	31,397	Santa Fé	4,172
Córdova	2,578	Santander	5,602
Daan-bantayan	18,874	Sibonga	19,209
Dalaguete	35,125	Tabongon	19,455
Danao	26,204	Talisay	10,607
Del Pilar	12,475	Toledo	24,714
Dumanjug	33,350	Tuburan	47,886
Ginatilan	9,083	Tudela	6,886
Liloan	24,510		
		Total	1,009,973

There are sufficient signs that tend to show that the present poultry population of the province is considerably larger than that reported in 1918. Most of the fowls are raised in the mountains and on the farms; the rest are raised in the back yards in the barrios and towns. The largest flock of chickens seen during this visit consisted of only about 70 birds.

Of the other species of poultry, Cebu has very few. Geese and turkeys are raised to a very limited extent. No ducks were seen in the places visited.

It was surprising to note that the chickens raised in Cebu do not show even a slight influence of any of the foreign breeds of fowls now common in the Islands. There is, however, a definite and distinct type, not unlike the Indian Game fowl. The birds have rather broad chest, plenty of meat, broad shoulders and unmistakable signs of strong wings. The feathers are rather tight, and for this reason, the birds weigh much heavier than the size would indicate. The color is as much like that of wild fowls as the color of the unimproved Native fowls in Luzon, although black seems to be the predominant color.

If the Indian Game fowl was the probable origin of the Cebu chickens, a possible theory on account of the close connection of the port of Cebu with the various ports of the East Indies since the early days, the Cebu fowls have degenerated considerably in size. Without doubt, however, the Cebu chickens would furnish an excellent foundation stock should it be desired to develop a meat breed of Native chickens.

Management. The chickens of Cebu are raised in the most primitive way. In very rare instances are houses specially built for them. Most houses on the farms, however, are provided with enclosures underneath. According to information received from their owners, the chickens are not kept in enclosure except during the planting seasons, of which there are two during the year, when the chickens are confined until the corn plants are about half a meter high. During the other months of the year, the birds roost in trees. There is no definite season for hatching and brooding, as is the case in most places in the Islands.

The chickens are fed mostly with *tahup*, supplemented with copra meal at times and once in a while, grated fresh coconut is also given. In the visits made to a number of markets in various towns in Cebu, it was observed that a certain kind of fish, *Anchovia* spp., *dilis* (Tag.) may be bought at very reasonable prices. If this fish were used to supplement the *tahup*, an efficient ration both for growth and egg production would be provided.

Hardly any attention is paid to the selection of the stock used for breeding. Because the larger birds command higher prices in the market than the smaller ones, the producers in most cases, probably in all, market the large chickens in preference to the smaller which are kept and allowed to multiply. One of the important measures that may be taken to effect an improvement of the size of the Cebu chickens is to conduct a campaign of selection and culling, caponizing all the males that do not reach a certain standard in size within a certain age limit. As it is now, all the males are kept till they are marketable, a stage far beyond the breeding age. About 80 per cent of all the chickens shipped on the *S. S. Cebu* for Manila on May 26, 1931 were males ranging in age from about a year to over two years, as judged from the size and development of their spurs. Capons were conspicuous in this shipment for their absence. In fact during the trip in Cebu very few capons were seen.

It was observed that the people of Cebu are most eager to learn better methods of raising poultry and a more efficient system of feeding than the present methods used. In general, they are probably more poultry-minded than in most other provinces in the Islands. They realize the money value of chickens and for this reason they are anxious to know better methods that they may raise larger chickens in larger numbers.

Marketing. Although the system of marketing poultry and eggs followed in Cebu is fairly well organized, there is still plenty of room for improvement. Also, if definite standards for both poultry and eggs were established, there would be less guess work and in consequence less risk on the part of the buyers and possibly better prices for the producers than they are now getting for their products. Hence, all parties concerned in the marketing of poultry and eggs would be benefited. It is not out of place here to state again that the excellent roads and ease of transportation throughout the island of Cebu are two of the important factors that greatly aid in the present developed marketing of poultry and eggs in the province.

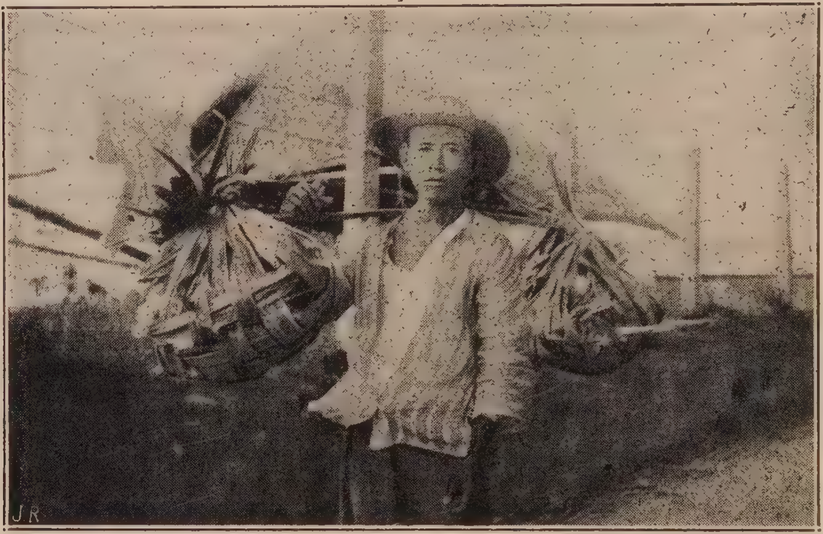

Fig. 2.—A farmer taking some of his marketable chickens to the poultry exchange in Consolación, Cebu.

The Poultry exchanges. Another factor that exerts considerable influence in the poultry industry of Cebu are the markets that are located in strategic places either in towns or outside in places easily accessible to people living on the farms or in the mountainous regions of the province. In a number of these markets are highly developed "poultry exchanges" where both poultry and eggs are delivered to the wholesalers or their agents. There are also local buyers, the hucksters, who go around from house to house in the mountains and on the farms and collect poultry and eggs direct from the producers.

Named in the order of importance from the point of view of the poultry exchanges, some of these markets are here listed, together with their respective market days:

Market	*Location*	*Market Day*
Bogo	North	Sunday
Mantaloñgon	South Central	Thursday
San Fernando	Central	Sunday
Sañgat	Central	Friday
Dumanjug	South West	Saturday and Tuesday
Ronda	South West	Tuesday
Toledo	West	Sunday
Consolación	North Central	Tuesday
Opon	Mactan Island	Sunday

The Bogo market has by far the most important poultry exchange in the province. This market is located at the extreme northern end of the island and all chickens produced in the towns of Bantayan, Madridejos, Sta. Fé, San Remigio, Medellin, Daanbantayan and Bogo are taken to the Bogo market. As a matter of fact, most of the chickens that are brought to Cebu from the northern part of the island are called "Bogo" chickens, and this name is almost a password to the wholesalers of poultry in Cebu because of the popularity of these fowls.

The poultry exchange is not located in the market proper, but outside the market gate. In the case of the Mantaloñgon market, the exchange is at least one-half kilometer from the market. In the two other markets visited, Sañgat and Consolacion, the exchanges are located only about fifty meters away. The reason for outside the market is to avoid the payment of high market fees. In Mantaloñgon, two centavos is charged for each chicken sold, while outside, in the exchange, the fees charged are ten centavos for every dozen or more, five centavos for five or more; if only three or less are sold, no fees are charged.

The chickens and eggs are brought to these exchanges by the farmers. Because the chicken is a recognized commodity of trade in Cebu, the producers can sell all of their marketable stock; the number they do sell each week, in some cases, depends upon how much cash they need to pay for their household expenses for the week. Sometimes only one is sold; sometimes a dozen or more are taken to the exchange at a time. Occasionally, there are small buyers who meet the producers some distance from the exchange and collect the chickens and resell them to the wholesalers or their agents stationed in the exchange for whatever advance in price they can get.

In these exchanges, five standard classes of chickens are recognized,—first, second, third, fourth and fifth classes, based upon the weight of the birds as determined by simple approximation. To the first class belong the chickens, male or female, that weigh about one and one-half kilograms or more each; to the second class, those that weigh from one to one and one-half kilograms; to the third class belong those that weigh about three-fourths to one kilogram; and to the fourth class those that weigh one-half to three-fourths kilograms; and to the fifth class those that weigh from one-fourth to one-half kilogram. As no scales are used, the sellers depend upon the arbitrary classification made by the buyers who are more or less accurate in their estimates. For the producer it is a matter of abiding by the classification made and sell the chickens or disagree with it and take the chickens back home.

In the Mantaloñgon exchange, the chicken is handed to the buyer, who decides on the class and tells his assistants to place it in the crate where it belongs. All estimates are made very quickly and judging from the speed with which the work is done, the buyer may be considered an expert in his work. What is rather remarkable in connection with these transactions is that during two hours of observation where probably not less than three hundred chickens had been handled and classified, not a single complaint was heard from the sellers.

Prices. As is the case with other commodities, the prices paid for the chickens vary in the different parts of the year, depending upon the supply available in the market. According to a wholesale buyer, many more chickens are sold in the markets during April, May and June and November, December and January than during the other six months. These months approximately coincide with the corn planting seasons in Cebu, the period during which the chickens have to be confined under the houses. The practice is to sell all available marketable stock except pullets and young hens, to avoid having to feed them and take care of them in confinement. This condition lowers, to a certain extent, the prices of chickens.

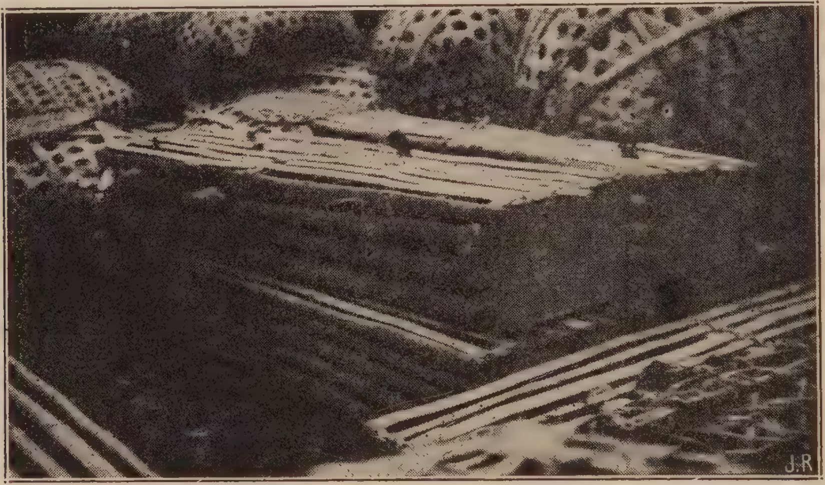

Fig. 3.—Specially constructed bamboo crates used in shipping chickens to the "warehouses" in Cebu. These containers are very convenient to carry as they fit very nicely in the rear end of the trucks.

At the time of the visit in Mantaloñgon market, May 28, 1931, the current prices paid for the different classes, compared with wholesale prices in Manila were as follows:

Class	Size	Prices of chicken in	
		Mantalongon	Manila
	kgm.		
First......	1.5 or over	₱7.00 a doz.	₱11.00 a doz.
Second....	1.0 to 1.5	4.80	9.00
Third.....	0.75 to 1.0	3.60	7.00
Fourth....	0.50 to 0.75	3.00	5.00
Fifth......	0.25 to 0.50	2.40	4.00

The Chicken "Warehouses" in Cebu. From the poultry exchanges in the different markets, the chickens are taken to the city of Cebu either in trucks or on the train and collected in the "warehouse" (*bodega sa manok,* Vis.) where they are resorted and prepared for shipping to Manila. Sometimes these fowls are shipped to Cebu in regular export crates, a bamboo basket measuring approximately two meters by one meter by about one-half meter, and specially reinforced to prevent them from collapsing (see fig. 5.). Other types of containers used are shown in figures 3 and 4.

From the description furnished by one of the exporters who happened to be on board the boat on which the writer went to Cebu, the impression was received that these warehouses were buildings especially constructed where the chickens were cared for and fed while waiting for available transportation. As a matter of fact, however, they are nothing of the kind. The crates containing the chickens are simply scattered under and around the shippers' houses or those of their agents, where the chickens are left to the mercy of the rain or the sun or any other element. It is indeed a sorry sight, for although the chickens were "fed" and "watered" while in the warehouse waiting for shipment, it is obvious that they get a very limited amount of either of these necessities. Occasionally, birds die of suffocation from overcrowding and fighting for a share of the grain thrown to them.

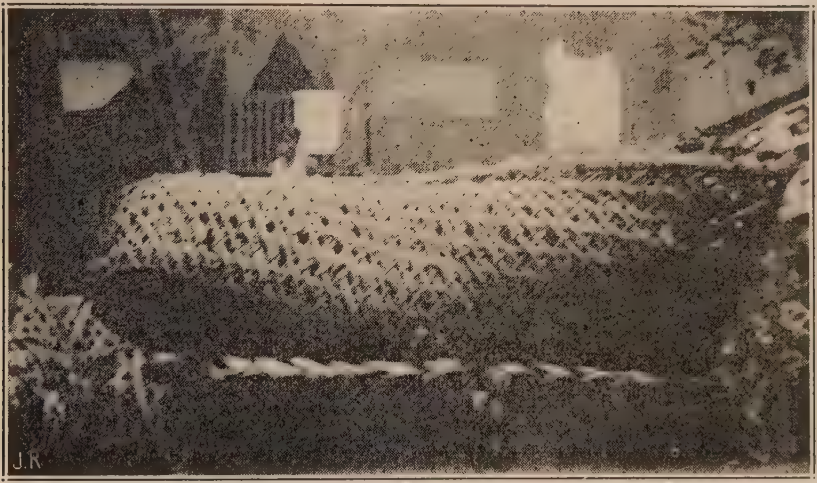

Fig. 4.—A specially constructed shipping crate made of rattan. This type is not as convenient as that shown in figure 5 and it is not as solid.

Exporting. About 80 per cent of the chickens exported from Cebu are sent to Manila and the rest are shipped to Davao where there is a growing market for poultry. Most of the chickens shipped to Manila are carried on the Compañía Marítima boats, the bulk being carried by the *S. S.*

Cebu which leaves Cebu for Manila on Tuesdays. This vessel is favored by the big dealers, although it is a rather slow boat, because of the advantage of the boat's schedule. Chickens are bought in the important chicken markets on Sundays, collected in the city on Mondays and shipped to Manila on Tuesdays. Besides this advantage in schedule, the *S. S. Cebu* being a direct Cebu-Manila boat, stays in port longer than other boats, thus giving plenty of time for the loading of the chicken crates, which is a very slow process. The *S. S. Panay* is also a direct Cebu-Manila boat and stays in port as long as the *S. S. Cebu,* but it leaves Cebu on Sundays.

The export trade is mostly in the hands of private individuals. From a reliable informant, a certain captain of one of the inter-island vessels is also engaged in the exportation of chickens from Cebu to Manila. All told, there are at least ten individuals who make it a regular business to buy chickens in Cebu and ship them to Manila. Four of these dealers, consign their stock on the *S. S. Cebu.* These dealers go to Manila with the chickens every week and when they return to Cebu, they take merchandise consisting mostly of vegetables and fruits in season; some take household goods that may be traded for chickens with the producers living on the farms.

Shipping expenses. The chickens in crates are carried from the warehouses to the steamers mostly in "calesas" drawn by men. (See fig. 5.) For each trip of the calesa from the warehouse to the waterfront ten to twenty centavos is paid, depending upon the distance. A calesa load consists of six crates. The number of chickens in each crate varies according to the size of the birds. The following tabulation gives the accepted standdard:

CLASS OF CHICKENS	NUMBER IN EACH CRATE
	dozen
First	4.5
Second	5
Third	6
Fourth	7
Fifth	8

The freight charged for each crate on board from Cebu to Manila is ₱2.00. For each empty crate on the return trip to Cebu, ten centavos is charged. At first glance, it was thought that the shippers' expenses must be enormous, considering that he had to pay his fare to and from Manila, but it was learned that shippers who accompany their merchandise on board get free transportation from Manila to Cebu and back with first-class passenger privileges.

The chickens exported. The size of the chickens exported from Cebu to Manila belong mostly to the first, second and third classes, although some fourth and fifth classes are also sent, depending upon the demand in Manila.

According to a rough estimate by one of these dealers, the approximate distribution of the stock he shipped last year was as follows:

First class	15 per cent
Second class	25 per cent
Third class	30 per cent
Fourth class	20 per cent
Fifth class	10 per cent
Total	100 per cent

It may be mentioned in this connection that this particular dealer in addition to maintaining chicken stalls in both the Divisoria and Quinta markets also caters to the needs of a certain restaurant in Manila and for this reason he makes an effort to get the smaller classes of chickens. His figures, therefore, cannot be taken as an indication of the general conditions existing in Cebu. The other poultry shippers dispose of their stock to the various retailers in these markets.

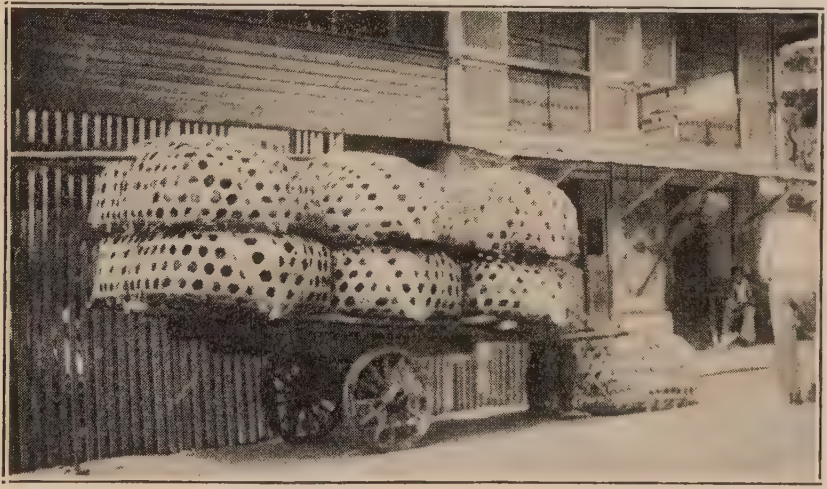

Fig. 5.—A "calesa" loaded with crates of chickens. This is drawn by man.

According to several dealers, comparatively fewer of fifth class than the other classes of chickens are shipped from Cebu, because they are more difficult to handle, there is greater risk from mortality in shipping, and also they consume much more feed than the larger ones. Add to these disadvantages, the probable more important reason, that the producers in Cebu seldom sell the small chickens because they prefer to wait until they grow bigger and realize more money from their stock. During the week of the visit, the Manila markets demanded more fourth and fifth classes of chickens, but the exporters would make no effort to supply this demand unless the retailers, or the stall owners in the Manila markets, would pay slightly higher prices for them.

Care of the chickens on board. There is much room for improvement in the handling of chickens on board the vessels. The crates are placed on the deck, and with as large a shipment of chickens as the *S. S. Cebu* carried on its trip to Manila on May 26, 1931, which consisted of a little over 100 crates, these had to be piled in such a way that neither feeding nor watering was possible, except with considerable amount of effort. (See fig. 6.) Considering the fact that the chickens had not had sufficient feed during the collection time prior to the loading, and that the duration of the trip from Cebu to Manila, is about 36 hours on the *S. S. Cebu* and about 24 hours on the other boats, the shrinkage in weight of these chickens must be considerable. The mortality, however, even under these most trying conditions is practically nil. This is made possible only by the care that the buyers exercise in refusing to buy birds that have weak constitutions.

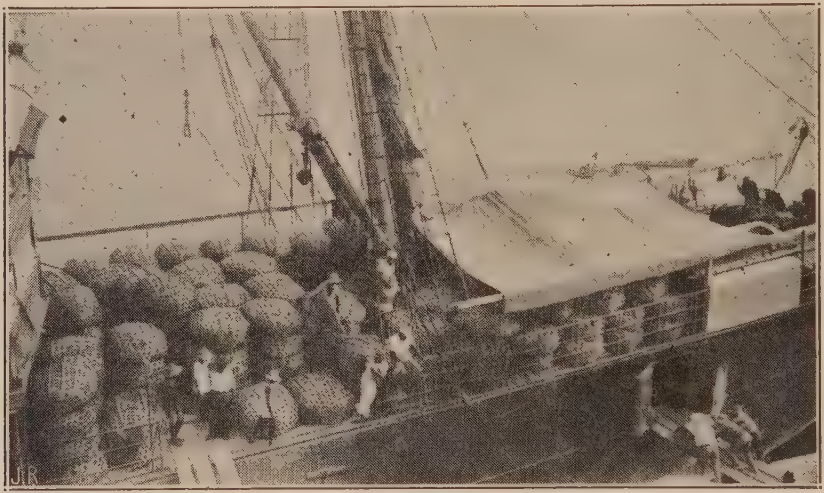

Fig. 6.—The "chicken deck" of the *S. S. Cebu* about one hour before it left for Manila on May 26, 1931.

Eggs. It may be noticed that very little mention has been made in this report of the egg business of Cebu. The reason is that the egg business is of little importance now. The egg exporting business of Cebu used to be active but the various egg dealers have stopped shipping eggs to Manila as it is now impossible to compete with the Chinese eggs in the Manila markets. It may be mentioned here, that for the present there is no danger of shortage of eggs in Cebu, the province can supply all that it needs. A certain amount of these find a market in Davao, but most of the eggs produced in the province are now used locally.

The eggs are small and the quality is not guaranteed. According to a Cebu egg dealer, the eggs are held in the store sometimes three or even four weeks from the time of delivery to the time they are sold. At the time of the visit, eggs were selling at ₱1.80 a hundred, wholesale, and were being retailed at ₱2.00 a hundred.

The egg exporting business is not as profitable as the chicken business. There is more risk connected with it and the profit is comparatively smaller. Sometimes, as many as fifty per cent of the eggs are rotten when the shipment reaches Manila, especially during the hot season. In some instances, also, according to information received, the egg cases are maliciously placed near the boilers, which naturally helps to discourage any one who may be interested in the exporting of eggs from Cebu.

Some observations were made on the method of retailing eggs in Cebu. In the egg store, the eggs, piled in large baskets, are exposed to the heat and dust. When a buyer comes around, he is given a free hand in the selection of what he wants. The method used in determining egg quality is by shaking the eggs. Naturally, the buyer picks the larger eggs, and those the contents of which do not pound. Thus, the tendency is towards a deterioration of the quality of the eggs left in the store. With a little additional expense, and a little more trouble on the part of the retailer, the service might be greatly improved.

AMOUNT OF NUTRIENTS IN PHILIPPINE FOOD MATERIALS[1]

F. O. SANTOS AND S. J. ASCALON
Of the Department of Agricultural Chemistry

INTRODUCTION

To select food properly, it is important to know the total amount of nutrients present as well as the percentages. In the great majority of Filipino homes the use of the balance and graduated measuring cup is still unknown. Although some food materials, such as meat, are bought by weight, by far the greater part, as the common fruits, eggs, crabs and bread are bought by the piece. Hence, it should be convenient to have a table giving the amount of constituents present in the common units of measure of the different food materials.

Uses of food. Food supplies building materials for the growth of the different parts of the body in the young and for the maintenance and repair of these parts in the adult. It supplies energy for the various activities of the internal organs which are necessary to sustain life, and for the performance of work. The energy requirement is measured in calories.

COMPOSITION OF FOOD MATERIALS

Ordinary food materials, such as palay, fish, meat, eggs, bananas, etc., consist of refuse and edible portion.

Refuse is the portion of food which we can not or do not eat and which would have little or no nutritive value if eaten. In palay, the refuse is the husk; in fish and meat, the bones; in eggs, the shell; in bananas, the skin; and in santol and chico, the skin and seeds.

The *edible portion* of the food consists of water, protein, fat, carbohydrates, mineral, or ash. These four substances are called nutrients or nutritive ingredients. Combined with these nutrients in some unknown way are the vitamins.

Water in food is sometimes called moisture. The importance of this foodstuff to the body will be realized if one will try to live without drinking even for a day. Each kind of food, no matter how dry it may appear, contains water. When a food is sold by weight, and especially when its cost is high, it is essential to have an idea of the amount of water it contains. Good wholesome water can be cheaply and easily obtained from other sources.

Proteins are the principal materials used for the construction and repair of the body. They are abundant in egg, meat, fish, mungo, and peanut. Foods which are high in protein are usually expensive. *Carbohydrates* and

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fats supply the fuel need of the body. Fat is a more concentrated source of heat than carbohydrates, but it costs more. The cereals and root crops are excellent sources of carbohydrates. Sugar and starches are the most common carbohydrate foods. Some carbohydrates usually called crude fiber, or cellulose are indigestible. Crude fiber is abundant in vegetable foods. It is useful in giving bulk to the food residue which facilitates its passage along the digestive tract. The digestible carbohydrates are called nitrogen free extract (N. F. E.) *Minerals*, or ash are essential in the formation of blood and bones. Fruits and vegetables are rich in minerals.

The *vitamins* are accessory food factors the exact nature and rôle of which are still unknown. They probably mean to the body something the same as oil means to a machine. The oil does not supply fuel to the machine, but without oil the machine will not run smoothly. So a lack or insufficiency of vitamins affects the body, producing nutritive effects as of insufficient or improper nutrition. Such diseases as beriberi, scurvy, etc., result.

"Besides the nutrients that the body uses, it is also essential to take roughage, that is, indigestible matter which gives bulk to the feces and thus helps prevent constipation. The fruits and vegetables contain abundance of indigestible material which serve as roughage."

PREPARATION OF TABLE

Unit of measure. The unit of measure in this work is that by which the given food material is usually sold. Investigation on this point was made in different markets so as to be sure that the unit of measure recorded was the one commonly used.

Average weight or size. By this is meant the weight or size of the food material per unit of measure. To obtain the average weight or size, at least six samples of the food material were weighed.

Calculations. The amount of the food constituents per unit of measure was calculated as follows:

a. Duck egg:—Unit of measure	1 egg
Average weight	74 grams
Edible portion	63 grams

Proximate analysis:

Moisture	72.05%
Ash	0.98%
Protein	13.04%
Fat	13.92%

Amounts of constituents:

Moisture	0.7205×63=45.3915 or (45 grams)
Ash	0.0098×63= 0.6174 or (1 gram)
Protein	0.1304×63= 8.2152 or (8 grams)
Fat	0.1392×63= 8.7696 or (9 grams)

An average fresh duck egg then contains the following amounts of food constituents:

Moisture	45 grams
Ash	1 gram
Protein	8 grams
Fat	9 grams

b. Ates:—Unit of measure	1 fruit
Average weight	195 grams
Edible portion	114 grams
Proximate analysis:	
Moisture	76.18%
Ash	0.73%
Protein	1.67%
Fat	1.10%
Carbohydrates:—	
Crude fiber	1.16%
N. F. E.	19.16%

Amounts of constituents:

Moisture	0.7618×114=86.85 or (87 grams)
Ash	0.0073×114= 0.83 or (1 gram)
Protein	0.0167×114= 1.90 or (2 grams)
Fat	0.0110×114= 1.15 or (1 gram)
Carbohydrates:—	
Crude fiber	0.0116×114= 1.32 or (1 gram)
N. F. E.	0.1916×114=21.84 or (22 grams)

An ates of average size then contains the following amount of food constituents:

Moisture	87 grams
Ash	1 gram
Protein	2 grams
Fat	1 gram
Carbohydrates:—	
Crude fiber	1 gram
N. F. E.	22 grams

Fuel value. The fuel value is the number of calories of heat equivalent to the energy which the body would be able to obtain from a food, provided the materials were completely digested. One gram each of carbohydrate and protein gives 4.1 calories and one gram of fat, 9.3 calories. The other constituents of the food have no heat value. Crude fiber, which is also a carbohydrate, is indigestible. Hence in the calculation, the term carbohydrate applies to nitrogen free extract only.

An ates of average size then has 108 calories in food value, as shown below.

Proteins	2×4.1 calories =	8.2
Fats	1×9.3 calories =	9.3
Carbohydrate:		
(N. F. E.)	22×4.1 calories =	90.2
		107.7 or 108 calories

Many of the analytical data used in the calculation of the amount of nutrients were taken from *The Chemical Composition of Philippine Food Materials* by F. O. Santos and F. T. Adriano, 1929. Published by the Office of the Public Welfare Commissioner, Department of Interior, Manila, Philippine Islands. The others were obtained by the authors themselves, for this paper.

The Chemical Composition of American Food Materials 1906 (Bulletin No. 28, Revised Edition) by W. O. Atwater and A. P. Bryant, Office of the Experiment Station, U. S. Department of Agriculture, Washington, D. C., U. S. A., was used as reference.

Table showing amount of nutrients in Philippine food materials

	UNIT OF MEASURE	AVERAGE WEIGHT	REFUSE	EDIBLE PORTION	WATER	ASH	PROTEIN	FAT	CARBOHYDRATES		FUEL VALUE PER UNIT OF MEASURE
									Crude fiber	N.F.E.	
Animal foods		grams	grams	grams	grams	grams	grams	grams	grams	grams	calories
Beef:											
Boneless meat..	1 kgm.	1000	118	882	538.	9.	168.	168.	—	—	2251
Meat with bone...	1 kgm.	1000	265	735	442.	7.	139.	147.	—	—	1937
Pork	1 kgm.	1000	266	734	358.	6.	106.	264.	—	—	2890
Chicken	1 kgm.	1000	259	741	470.	7.	143.	121.	—	—	1712
Turkey	1 kgm.	1000	227	773	425.	8.	163.	177.	—	—	2315
Eggs:											
Duck egg (fresh)	1 egg	74	11	63	45.	1.	8.	9.	—	—	117
Duck egg (hard boiled)	1 egg	74	11	63	45.	1.	9.	9.	—	—	121
Duck egg (cooked balut)	1 egg	75	11	64	45.	1.	10.	8.	—	—	115
Hen egg (fresh)	1 egg	44	5	39	28.73	0.42	4.90	4.69	—	0.26	65
Cheese:											
Cheese, Cebu	1 cake	1000	—	1000	461.	43.	233.	233.	—	30.	3245
Cheese, Sta. Cruz	1 cake	102	—	102	54.	4.	16.	23.	—	5.	300
Fish:											
Fresh:											
Anchovy, *Anchovia commersoniana* Lacepede; dilis (Tag.)[a]	1 fish	8	2	6	4.77	0.07	1.09	0.04	—	0.03	5
Bastard shad, *Konsirus thrissa* Osbeck; kabasi (Tag.)	1 fish	46	20	26	19.17	0.48	5.20	1.12	—	0.03	32
Caesio, *Caesio chryeosona* (kuhl) Van Hassel; dalagang-bukid (Tag.)	1 fish	81	28	53	41.69	0.64	10.30	0.37	—	—	46
Catfish, *Artus* sp.; kanduli (Tag.) gague (Moro)	1 fish	605	320	285	226.	4.	50.	4.	—	1.	242
Catfish, *Clarias batrachus* Linn. hito (Tag.)	1 fish	203	88	115	87.9	1.33	20.31	5.46	—	0.10	134
Croaker, *Johnius belengeri* Cuv. et Val. abo (Vis.)	1 fish	27	14	13	10.33	0.19	2.26	0.22	—	—	11
Drepane, *Drepane punctata* Gmelin; mayang (Tag.)	1 fish	406	218	188	146.	2.	37.	3.	—	—	180
Drum, *Umbrina russeli* Cuv. et Val.; apahap (Tag.)	1 slice	111	51	60	46.	1.	12.	1.	—	—	59
Flathead, *Platycephalus indicus* Linn.; sunog (Tag.)	1 fish	172	72	100	78.	1.	19.	2.	—	—	97
Flounder, *Pseudorphombus neglectus* Bleeker; palad (Tag.)	1 fish	73	37	36	28.85	0.56	6.27	0.18	—	0.14	28
Goby, *Glossogobius giurus* (Hamilton) Buchanan; biang-puti (Tag.)	1 fish	72	30	42	33.	1.	7.	1.	—	—	38
Grunt, *Pristopoma hasta* Bloch; ayuñgin (Tag.)	1 fish	32	17	15	11.88	0.23	2.79	0.10	—	—	12
Grunt, *Pomudasas argyreus* Cuv. et Val.; besugo (Tag.)	1 fish	29	17	12	9.08	0.42	2.12	0.11	—	0.27	11
Half-beak, *Hamiramphus* sp.; buguing (Tag.)	1 fish	57	23	34	26.12	0.47	6.99	0.42	—	—	33
Herring, *Harengula moluccensis* Bleeker; tunsoy (Tag.)	1 fish	12	4	8	6.35	0.13	1.31	0.20	—	0.01	7

[a] Tag. = Tagalog
Vis. = Visayan

Table showing amount of nutrients in Philippine food materials

	UNIT OF MEASURE	AVERAGE WEIGHT	REFUSE	EDIBLE PORTION	WATER	ASH	PROTEIN	FAT	CARBOHYDRATES		FUEL VALUE PER UNIT OF MEASURE
									Crude fiber	N.F.E.	
Animal foods		*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*calories*
Japanese mackerel, *Scomber japonicus* Houttyn; hasa-hasa (Tag.)	1 fish	53	28	25	18.7	0.38	5.36	0.57	——	——	27
Leather Jack, *Scomberoides tol* Cuv. et Val.; cassiaung (Tag.)	1 fish	87	45	42	33.0	1.	8.	1.	——	——	42
Marine eel, *Muraenesox cinereus* Forskål; palos (Tag.)	1 fish	199	98	101	81.	2.	18.	1.	——	——	83
Milkfish, *Chanos chanos* Forskål; bañgos (Tag.)	1 fish	191	62	129	94.87	1.65	27.61	4.46	——	0.41	156
Mudfish, *Ophicephalus striatus* Block; dalag (Tag.)	1 fish	656	302	354	273.	5.	71.	5.	——	——	338
Mullet *Mugil cephalus* Linn.; banak (Tag.)	1 fish	54	24	30	22.76	0.41	5.53	1.30	——	——	35
Purgy, *Sparus calamara* Russel; bakoko (Tag.)	1 fish	22	10	12	9.09	0.16	2.52	0.23	——	0.002	12
Sardine, *Sardinella longiceps* Cuv. et Val.; tamban (Tag.)	1 fish	39	14	25	18.83	0.40	4.80	0.65	——	00.32	27
Scatophagus, *Scatophagus argus* Gmelin; kitang (Tag.)	1 fish	105	65	40	31.	1.00	6.00	1.00	——	1.00	38
Therapon, *Therapon puta* Cuv. et Val.; bugaong (Tag.)	1 fish	71	35	36	27.	1.00	7.00	1.00	——	——	38
By-products:											
Dilis, *Anchovia* sp. (dried salted fish)	1 ganta	204	——	204	38.2	28.00	132.00	3.00	0.35	2.00	577
Tinapa, *Clupeidae*, (smoked fish)	1 fish	7	3	4	2.12	0.33	1.45	0.06	0.01	0.03	7
Tuyo, *Clupeidae*, (dried salted fish)	1 fish	5	2	3	1.26	0.43	1.07	0.18	0.01	0.05	6
Shellfish:											
Fresh:											
Alimañgo, (unidentified)	1 crab	191	80	111	94.	2.00	8.00	3.00	——	4.00	77
Alimasag, (Unidentified)	1 crab	204	88	116	94.29	3.25	15.22	2.76	——	0.48	90
Capios, (Unidentified)	1 shell	39	35	5	4.38	0.13	0.38	0.02	——	0.09	2
Halang, *Fasciolaria trapezium* Linn.	1 shell	21	14	7	5.33	0.15	0.94	0.10	——	0.48	7
Litog, *Arca granosa* Linn.	1 shell	27	21	6	4.77	0.08	0.64	0.03	——	0.47	5
Pusit, (Unidentified)	1 squid	60	1	59	43.77	1.40	6.99	0.31	——	6.53	58
Salt water shrimp, *Penacus* sp. (Herre)	1 hill	152	57	95	69.00	2.00	20.00	3.00	——	1.00	114
Susong dagat, *Certhium vertagus* Linn.	1 kgm.	1000	796	204	164.00	14.00	17.00	1.00	——	8.00	112
Susong tabang, (Unidentified)	1 kgm.	1000	709	291	231.00	13.00	31.00	2.00	——	13.00	199
Talaba, *Ostrea orientalis* Chemmitz	1 shell	175	144	31	26.00	1.00	2.00	1.00	——	1.00	22
By-products:											
Bagoong (alamang), salted small shrimp	1 tablespfl	56	——	55	36.96	11.27	5.71	0.63	0.43	——	29
Fresh water shrimp (salted)	1 group	105	27	78	11.0	15.00	43.00	2.00	3.00	3.00	207
Gulaman	1 bundle	38	——	38	6.77	1.31	1.60	0.45	——	27.89	125
Plant foods											
Rice	1 plate	167	——	167	136.00	1.00	3.00	1.00	1.00	25.00	124
Corn	1 ganta	1000	120	880	118.00	15.70	66.50	25.00	28.00	627.00	3076

Table showing amount of nutrients in Philippine food materials

	UNIT OF MEASURE	AVERAGE WEIGHT	REFUSE	EDIBLE PORTION	WATER	ASH	PROTEIN	FAT	CARBOHYDRATES		FUEL VALUE PER UNIT OF MEASURE
									Crude fiber	N.F.E.	
Plant foods		*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*calories*
Bread:											
Amor mío	1 roll	10	——	10	0.85	0.14	0.17	1.51	0.03	7.31	45
Galletas	1 roll	12	——	12	1.03	0.19	1.43	1.61	0.03	7.72	52
Mamon (Los Baños)	1 roll	9	——	9	1.95	0.10	0.78	1.16	0.03	4.99	34
Pan de sal	1 roll	53	——	53	15.14	0.51	3.33	4.45	0.14	29.42	176
Pan Americano	1 loaf	540	——	540	55.00	5.00	56.00	30.00	2.00	392.00	2116
Pilipit	1 roll	10	——	10	0.96	0.03	0.71	0.73	0.02	7.57	41
Soda biscuit	1 roll	8	——	8	0.91	0.07	0.76	1.07	0.02	5.17	34
[b]Lard substitute (vegetable oil, as mante-coco etc.)	1 kgm.	1000	——	1000	——	——	——	1000.00	——	——	9300
Mique	1 kgm.	1000	——	1000	202.00	25.00	16.00	16.00	——	741.00	3253
Misua	1 bundle	23	——	23	5.90	1.09	0.48	0.48	——	15.05	68
Sugar (centrifugal)	1 kgm.	1000	——	1000	29.00	——	——	——	——	971.00	3981
Vegetables											
Fruits:											
Amargoso (ampalaya), *Memordica charantia* Linn.	1 fruit	76	23	53	49.14	0.36	0.67	0.02	0.06	2.75	14
Batao (batao), *Dolichos lablab* Linn.	1 pod	8	2	6	5.25	0.06	0.20	0.02	0.10	0.37	3
Bottle gourd (opo), *Lagenaria leucantha* (Lam.) Rusby	1 kgm.	1000	350	650	620.36	2.42	3.00	0.60	1.70	22.00	108
Breadfruit (camansi), *Artocarpus communis* Linn.	1 fruit	632	112	520	464.00	5.00	12.00	3.00	6.00	32.00	208
Chick pea (garbanzos), *Cicer arietinum* Linn.	1 kgm.	1000	——	1000	136.00	29.00	199.00	54.00	23.00	559.00	3610
Common bean (habichuelas), *Phaseolus vulgaris* Linn.	1 kgm.	1000	——	1000	151.00	38.00	181.00	17.00	43.00	471.00	3241
Cowpea (sitao), *Vigna sesquipedalis* Linn.	1 bundle	140	6	134	116.24	1.21	3.55	0.24	2.72	10.04	58
Cucumber (pepino), *Cocumis sativus* Linn.	1 fruit	850	250	600	577.00	3.00	3.00	1.00	2.00	14.00	79
Eggplant (talong), *Solanum melongena* Linn	1 fruit	103	——	103	93.71	0.56	1.10	0.46	0.84	6.32	35
Horse radish tree (malungay), *Moringa oleifera* Lam.	1 pod	16	——	16	14.11	0.15	1.17	0.03	0.12	0.42	7
Lima bean (patani), *Phaseolus lunatus* Linn.	1 pod	11	2	9	5.89	0.17	0.66	0.11	0.07	2.10	12
Mungo seed (Japanese mungo), *Phaseolus areus* Roxb.	1 liter	840	——	840	123.50	25.00	172.00	8.00	37.00	475.00	2727
Papaya (papaya), *Carica papaya* Linn. (green)	1 fruit	425	147	282	265.03	1.16	3.07	0.48	1.83	10.43	59
Sponge gourd (patola), *Luffa cylindrica* Roem.	1 fruit	459	195	264	249.70	0.70	1.66	0.34	0.34	11.22	56
Sprouted mungo (togi) *Phaseulus mungo*	1 hill	161	——	161	148.40	.70	4.00	1.00	1.00	6.00	50
Squash (calabasa), *Cucurbita maxima* Duchesne.	1 kgm.	1000	177	823	717.70	8.3	11.00	3.53	5.80	77.00	394
Sugar pea (guisantes), *Pisum sativus* Linn.	1 kgm.	1000	74	926	787.00	7.00	36.00	2.00	13.00	81.00	498
Tomato (camatis) *Tomato* sp,	1 fruit	45	——	45	42.44	0.28	0.45	0.10	0.29	1.44	9
Wax gourd (condol) *Benicasa cerifera* Savi.	1 kgm.	1000	315	685	659.00	2.50	1.20	3.20	3.70	15.5	98
Winged beans (ciguidillas) *Psophucarpus tetragonolobus*	1 pod	25	——	25	24.26	0.16	0.46	0.13	——	——	——

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[b] Wrongly called "lard" by some Filipinos. Lard is the fat of hogs. The word cannot be applied to other fats. Mante-coco and other vegetable oil products are manufactured to be used in cooking as a substitute for lard.

Table showing amount of nutrients in Philippine food materials

	UNIT OF MEASURE	AVERAGE WEIGHT	REFUSE	EDIBLE PORTION	WATER	ASH	PROTEIN	FAT	CARBOHYDRATES		FUEL VALUE PER UNIT OF MEASURE
									Crude fiber	N.F.E.	
Vegetables		*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*calories*
Leaves:											
Amargoso (ampalaya)	1 bundle	61	21	40	31.18	0.82	0.92	0.05	0.30	6.73	32
Cabbage (repollo), *Brassica oleracea* Linn.	1 kgm.	1000	—	1000	919.	8.	20.	3.	9.	41.	278
Cancong (cancong), *Ipomea raptans* Poir.	1 bundle	106	34	72	64.59	1.20	3.06	0.03	0.50	2.62	24
Celery (cinchay), *Apium graveolus* Linn.	1 bundle	37	3	34	31.52	0.53	0.56	0.11	0.29	0.99	7
Chinese mustard (mustaza), *Brassica juncea* Linn.	1 bundle	53	—	53	48.40	0.58	1.09	0.16	0.42	2.35	16
Cowpea (sitao), *Vigna sinensis* (Linn.) Savi. et Haash.	1 bundle	99	33	66	56.69	1.04	2.69	0.26	1.25	4.07	30
Endive (escarola), *Chichorum endivia*	1 bundle	82	—	82	76.46	0.77	1.33	0.19	0.78	2.47	17
Fern (paco), *Athryim esculentum*	1 bundle	168	23	145	131.52	1.65	4.51	0.41	1.78	5.13	43
Garlic (bauang), *Allium sativus* Linn.	1 bundle	171	10	161	142.	2.	4.	0.51	2.	12.	70
Horse radish (malungay), *Moringa oleifera* Lam.	1 bundle	33	10	23	17.64	0.49	1.68	0.25	0.40	2.54	20
Leek (cuchay), *Allium porrum* Linn.	1 bundle	16	1	15	13.80	0.14	0.28	0.08	0.17	0.54	4
Pechay (pechay), *Brassica chinensis* Linn.	1 bundle	80	3	77	70.82	0.97	0.77	0.26	0.61	3.57	20
Pepper (sili), *Capsicum annum* Linn.	1 bundle	24	8	16	13.70	0.36	0.88	0.11	0.05	0.90	8
Pigweed (culitis), *Amaranthus oleraceus*	1 bundle	126	68	58	48.34	1.42	2.31	0.99	0.89	4.05	35
Squash (calabasa), *Cucurbita maxima*, Duchesne.	1 bundle	133	—	133	118.97	2.49	5.41	0.45	1.54	4.14	43
Sweet potato (camote), *Ipomea batatas* (Linn.) Poir.	1 bundle	39	14	25	21.06	0.50	0.29	0.11	0.48	2.56	13
Young onion (sibuyas) *Alium cepa*	1 bundle	34	3	30	26.75	0.22	0.38	0.10	0.54	2.01	11
Roots:											
Chinese radish (rabbanus), *Raphanus sativus* Linn.	1 tuber	127	38	89	83.79	0.61	0.73	0.14	0.49	3.24	18
Sweet potato (camote) *Ipomea batatas* (Linn.) Poir.	1 tuber	148	17	131	96.	1.	1.	1.	2.	31.	141
Taro (gabi), *Colocasia antigurum* Schott.	1 tuber	84	13	71	44.16	0.72	0.92	0.28	1.13	23.79	104
Yam (ubi), *Dioscorea* spp.	1 tuber	234	54	180	121.14	2.61	5.15	0.09	1.85	49.16	224
Yam bean (sincamas), *Pachyrrhizus erosus* (Linn.) Urb.	1 kgm.	1000	257	743	895.0	2.82	6.10	1.00	2.10	66.35	306
Shoots:											
Bamboo (labong) *Caña* sp.	1 kgm.	1000	302	698	928.	5.10	12.3	3.60	1.20	29.60	205
Flower:											
Banana (puso) *Musa sapientum* Linn.	1 flower	500	57	443	410.	5.	9.	1.	3.	15.	108
FRUITS											
Ates, *Anona squamosa* Linn. (fresh ripe fruit)	1 fruit	195	81	114	87.	1.	2.	1.	1.	22.	108
Avocado, *Persia americana* Mill.	1 fruit	390	141	249	215.	2.	6.	15.	8.	4.	181
Balimbing, *Averrhoa carambola* Linn.	1 fruit	48	—	48	45.07	0.20	0.12	0.36	0.29	1.96	12
Banana, *Musa sapientum* Linn. (different varieties)	1 fruit	106	36	70	50.20	0.67	0.92	0.41	0.33	17.48	79
Bignay—*Antidesma bunius* Spreng.	1 cup	148	30	118	112.	1.	1.	—	—	—	—
Camanchile, *Pithecolobium dulce* (Roxb.) Benth.	1 hill	45	21	24	18.80	0.11	0.59	0.08	0.31	4.11	20
Camias, *Averrhoa bilimbi* Linn.	1 fruit	10	—	10	9.48	0.04	0.07	0.14	0.06	0.22	2

Table showing amount of nutrients in Philippine food materials

	UNIT OF MEASURE	AVERAGE WEIGHT	REFUSE	EDIBLE PORTION	WATER	ASH	PROTEIN	FAT	CARBOHYDRATES		FUEL VALUE PER UNIT OF MEASURE
									Crude fiber	N.F.E.	
Fruits		*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*calories*
Chico, *Achras sapota* Linn.	1 fruit	69	10	59	42.78	0.37	0.30	—	—	—	—
Ciruela, *Spondias purpurea* Linn.	1 fruit	22	9	13	9.96	0.12	0.08	0.01	0.08	2.75	12
Duhat, *Eugenia jambolana* Lam.	1 fruit	4	1	3	2.42	0.02	0.02	—	—	—	—
Guayabano, *Anona muricata* Linn.	1 fruit	568	176	392	303.	3.	1.	—	—	—	—
Guava, *Psdium guajava* Linn.	1 fruit	45	—	45	36.74	0.33	0.43	0.03	3.08	4.39	20
Jackfruit, *Artocarpus integrifolia* Linn.	1 kgm.	1000	750	250	164.	3.08	2.4	—	—	—	—
Lanzones, *Lansium domesticum* Jack.	1 fruit	22	9	13	11.27	0.08	0.10	0.02	0.06	1.47	7
Mabolo, *Diospyros discolor* Wild.	1 fruit	182	53	129	106.	1.	1.	1.	2.	18.	87
Macopa, *Eugenia javanica* Linn.	1 fruit	35	4	31	28.33	0.08	0.16	—	—	—	—
Mango, *Mangifera indica* Linn. (fresh ripe fruit)	1 fruit	240	63	177	145.	1.	6.	2.	1.	22.	133
Mango, *Mangifera indica* Linn. (green)	1 fruit	175	43	132	115.27	0.50	0.91	0.11	1.23	13.98	62
Melon español, *Cucumis melo* Linn.	1 fruit	700	161	539	517.	3.	4.	—	—	—	—
Melon, *Cucumis melo* Linn.	1 fruit	765	191	574	544.	3.	1.	—	—	—	—
Papaya, *Carica papaya* Linn.	1 kgm.	1000	328	672	593.	6.00	5.00	1.34	8.00	58.0	271
Pineapple, *Anonas sativus lindi*	1 fruit	820	410	410	353.	1.	2.	—	—	—	—
Pomelo, *Citrus decumana* Murr.	1 fruit	895	349	546	479.	3.	4.	—	—	—	—
Santol, *Sandoricum koetjape* (Brum.) Merr.	1 fruit	93	32	61	51.	1.	1.	1.	1.	7.	42
Tamarind (ripe pulp) *Tamarindus indica* Linn.	1 pod	20	10	10	1.78	0.32	0.30	—	—	—	—
Tamarind (green) *Tamarindus indica* Linn.	1 pod	15	—	15	11.35	0.16	0.35	0.14	0.87	2.13	11
Watermelon, *Citrullus vulgaris* Shrad.	1 kgm.	1000	490	510	466.	.92	3.10	—	—	—	—
Fruit juices:											
Cajel, *Citrus aurantium* Linn.	1 fruit	127	53	73	67.90	0.27	0.29	—	—	4.54	20
Calamundin, *Citrus mitis* Blanco	1 fruit	16	9	7	6.28	0.04	trace	—	—	0.68	3
Narangita, *Citrus nobilis* Lour.	1 fruit	118	54	64	57.02	0.23	0.33	—	—	6.42	28
BEVERAGES											
Chocolate	1 cup	200	—	200	156.	1.	4.	10.	1.	29.	228
Coffee	1 cup	200	—	200	174.	1.	2.	2.	2.	19.	
Milk (different volume):											
Milk (U. P. College of Agriculture)	1 liter	1000	—	1000	844.	8.	44.	54.	—	50.	888
Milk (U. P. College of Agriculture)	1 glass	200	—	200	169.	2.	9.	11.	—	10.	180
Milk (Manila)	1 glass	200	—	200	169.	2.	9.	11.	—	10.	180

PLOWS AND PLOWING: IV
COST OF PLOWING WITH DIFFERENT PLOWING OUTFITS[1]

ALEJANDRO B. CATAMBAY
Of the Department of Agronomy and Department of Agricultural Engineering

WITH FOUR TEXT FIGURES

INTRODUCTION

The plow may be considered the basic tillage implement. The presence of many types on the market is the result of an intensive study by plow designers with the following aims: (*a*) To construct a plow which can be efficiently used on different field and soil conditions; (*b*) to construct one that will give satisfactory work, at the lowest possible cost; (*c*) to construct one that will turn out good quality of plowing with the least draft and power consumption.

Importance of the problem

Farmers in the Philippines seldom keep records that will show the efficiency of plowmen and different plowing outfits. It should be of great help to farmers if they could be furnished data relative to the efficiency and cost involved with the use of the different types of plows. With a knowledge of the average number of hours required to plow a unit area, hectare, with each of the different types of plow, it should be easy for a farmer or farm manager to decide on how many men should be hired to plow a field of known area within a certain time limit. The farmer or manager, however, should have a thorough knowledge of the different factors that affect the rate and efficiency of work. Such data will also help find out which plowmen are efficient and which are inefficient.

Object of the work

The objects of this study were: (*a*) To find the average length of time required to plow one hectare with different plows; (*b*) to find the cost of plowing one hectare with different outfits; and, (*c*) to determine the quality of work accomplished by each outfit.

Time and place of work

This study was carried from May, 1924 to June, 1925 and from August, 1928 to May, 1930. The plowing tests were made in the College Experiment Station.

TRACTOR AND PLOWS USED

The tractor used in the tests was the standard Fordson with a horse power of approximately 10 at the drawbar and 20 at the belt when the engine is running at 1000 revolutions per minute.

The plows used in this study are representative of the different types on the market. The specifications, construction, and fundamentals connected with the use of each of these types are included in the descriptions here given.

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[1] Experiment Station contribution No. 754. Received for publication January 12, 1931.

Native plow

The native plow used was the upland type. It has an average width of cut of 4 inches (10.16 cm.) and an average weight of 17.5 kilograms. The cost price, including accessories, is ₱17.

One disadvantage in its construction is that it has no landing adjustment. It is constructed so that it may be adapted to the habit of the animal, which may be to walk either on the land or in the furrow. The work animals in the College are trained to walk on the land about 15 to 30 centimeters away from the furrow bank, but commonly the Philippine farm animals are not given this special training. To maintain the regular width of cut, the plowshare is so mounted as to point from one to two centimeters to the right of a plane passing through the beam. Because of this peculiar construction, a native plow made for an animal which has the habit of walking on the land will considerably decrease the width of cut if used with an animal which walks in the furrow. This plow has, however, the necessary depth adjustments.

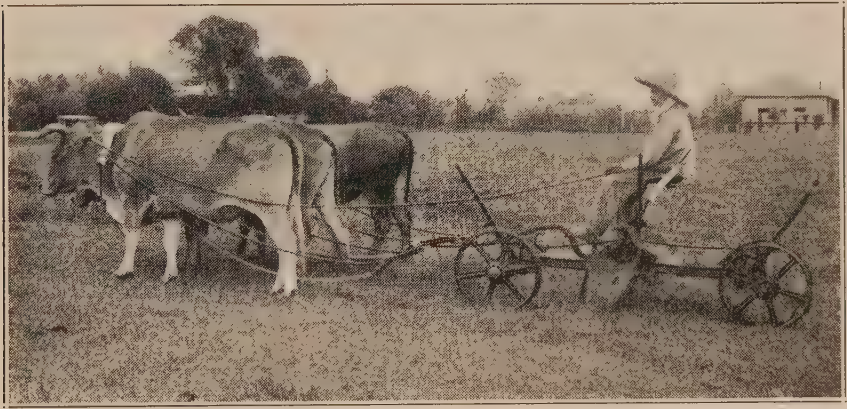

Fig. 1.—Three animals hitched to the Chattanooga 24-inch reversible disc plow.

Steel moldboard single animal plow

The more common plows that fall under this classification are the Amigo del Carabao, the Luzon Lagio, and the Negros. These plows have an average width of cut of 4 inches (10.16 cm.), an average weight of 18 kilograms. The cost price, including accessories, is ₱17. The necessary depth and landing adjustments are provided on these plows.

Reversible two-animal disc plow

The reversible plow used in this study was the Chattanooga. It has one disc with a diameter of 20 inches (50.80 cm.). The cost price, including accessories, is ₱175.

This plow is mounted on three wheels. The two furrow wheels are of the same size and have a diameter larger than that of the land wheel. There is a lever on each of the furrow wheels which makes it easy for the operator to make the necessary adjustments. In swinging the beam, the animals turn on the unplowed ground. The two furrow wheels are automatically adjusted and the disc is shifted to change direction. There is no loss of time in making the turns and the plow does not leave dead furrows.

Reversible three-animal disc plow

This plow, although of the same make, is more heavily constructed than the two-animal disc plow. It has one disc of 24 inches (60.96 cm.) diameter. The cost price, including accessories, is ₱236.

Tractor moldboard plow

The plow of this type used was the Oliver No. 7. It has two bottoms each with a 12-inch (30.48 cm.) cut. The cost price, including accessories, is ₱261.

This plow is mounted on two wheels. There is one lever for depth adjustment and another one for the power lift. The driver can manipulate the power lift lever from the tractor seat.

Tractor disc plow

The Oliver No. 42 disc plow was used for the test in this study. It has two discs of 24 inches (60.96 cm.) diameter. The cost price, including accessories, is ₱347.

The whole mechanism is mounted on three wheels. To counterbalance the thrust of the furrow slice on the discs, the two furrow wheels are inclined away from the land. The rear wheel is heavier than the other two so that it will not be lifted out of the furrow but will hold the plow in position. The power lift for raising the plow when turning can be easily operated by the driver. A trip rope is tied at the trip lever and connected to the driver's seat. There are two levers for the depth and level adjustments. To help the operator in manipulating these levers, heavy counter-balancing springs are provided. The discs are usually provided with scrapers which make it possible to use the plow on sticky soil. The scrapers do not only clean the discs but also help in turning over and pulverizing the furrow slices.

METHOD OF TESTING

The plowmen and work animals of the Agronomy Department were employed in this study. During the whole period that this work was in progress, 30 animals and 42 plowmen were employed.

The plowmen were assigned fields of known area to plow. The time in hours and fraction of an hour required to do the work was recorded. The time required in going from the corral was not included. The time, however, taken to hitch the animals to the plow in the field and also that consumed in the necessary stops and rests was included.

EXPERIMENTS AND RESULTS

With the native plow a total area of 104,775 square meters was plowed in 642.53 hours; with the single animal steel moldboard plow, 104,333 square meters were plowed in 645.15 hours; with the two-animal 20-inch disc plow 52,450 square meters were plowed in 289.67 hours; and with the three-animal reversible 24-inch disc plow an area of 48,641 square meters was plowed in 233.07 hours.

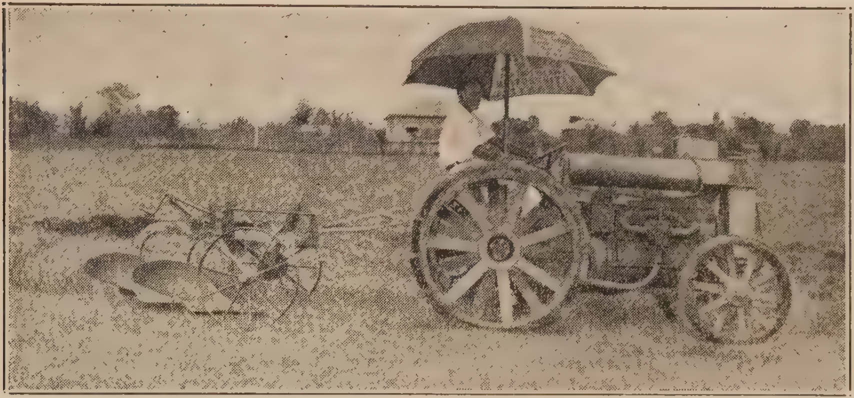

Fig. 2.—Two 12-inch bottom Oliver No. 7 moldboard plow hitched to a standard Fordson tractor.

In using the two 24-inch disc plow with a standard Fordson tractor an area of 393,127 square meters was plowed in 290.17 hours and with the same tractor but pulling a two 12-inch bottom moldboard plow, an area of 417,461 square meters was plowed in 329.38 hours.

The soil on which these different plow outfits were tried, is of the clay loam type. The area plowed with each plow and the length of time involved as shown in the figures given above, were the total for 50 trials distributed throughout the year.

The speed of work bullocks in plowing varied from 1.30 to 2.00 kilometers per hour and that of the tractor from 3.22 to 4.83 kilometers. The amount of work done a day depended largely upon the rate of travel and constancy of the work.

With the native and steel single animal moldboard plow in this study, the average depth was 11 centimeters. The speed of the animals was greatly reduced when the depth of plowing was more than 11 centimeters.

The average depth of tractor plowing was 15 centimeters. When the depth was more than 15 centimeters, the draft was increased and the speed was considerably decreased.

Computation of charges

The following formulas have been adopted by the writer for the computation of charges for all farm implements and machinery:

$$\text{Depreciation in pesos} = \frac{c\ d}{y\ m}$$

$$\text{Interest in pesos} = \frac{c\ r\ d}{365}$$

where c = cost of implement or machinery
d = number of 9-hour days used
m = maximum number of days used in one year
y = number of years of life of the implement or machinery
r = annual rate of interest

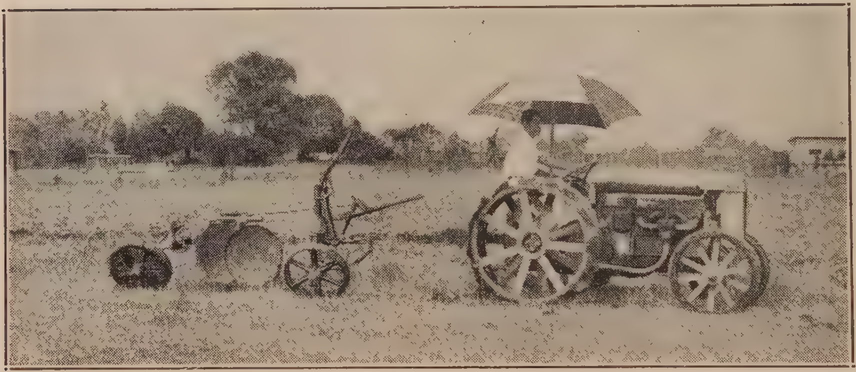

Fig. 3.—Two 24-inch disc Oliver No. 42 plow hitched to a standard Fordson tractor.

Cost of fuel and lubricant

In a series of tests for the determination of the daily (9-hour day) consumption of fuel and lubricant, the following was found:

a. Standard Fordson tractor (Model 1929):	
Gasoline—½ gallon (1.89 liters)	₱0.28
Petroleum—12 gallons (35.42 liters)	5.04
Oil—1 gallon (3.79 liters)	2.29
Grease—½ pound (0.23 kgm.)	0.10
Total	₱7.71
b. Reversible disc plow:	
Grease—¼ pound (0.11 kgm.)	₱0.05
c. Oliver No. 42 2-disc plow:	
Grease—½ pound (0.24 kgm.)	₱0.10
d. Oliver No. 7 2-point moldboard plow:	
Grease—¼ pound (0.11 kgm.)	₱0.05

Labor cost

The wages given the plowman and the tractor driver for one 9-hour day are ₱1.10 and ₱1.50, respectively.

Animal cost

The animal cost per day was considered in two ways. In the first case the animal is given a flat rate of ₱1.00 per day which is the average rate when hiring work animals. The second case is considered when the farmer owns the animal. This method of figuring for the daily animal cost includes depreciation of animals, care, charges on the use of pasture land and fences, and interest on all investments.

In computing the daily animal cost, the following figures were used; they were taken from actual conditions existing in the pasture for work animals of the Agronomy Department:

Daily depreciation of work animal and interest on the investment. The average price of work animal used is ₱120.00. Gonzalez (1926) found that a work animal has an average useful life of 7.1 years after which period it is only good for butchering, with a money value of about ₱50. The maximum number of days an animal is used in one year is considered as 250 days.

Depreciation in pesos	₱.04
Interest in pesos	₱.03

Daily use of pasture land. The pasture has a total area of 12 hectares and has 12 animals in it. The price of pasture land is considered as ₱300 per hectare and the land tax is .00875 per centum.

Land tax charged per animal	₱.01
Interest charged per animal	.01
Pasture land cost per animal	₱.02

Daily use of pasture fence. The pasture fence has a total length of 4000 meters. It is made of 4 strands of barbed wire with wooden posts. Considering the price of barbed wire as ₱7 per roll of 400 meters, the cost is ₱280. The value of staples for the initial fencing and for the repair of the fence throughout the life of the barbed wire is taken as ₱30. The average life of barbed wire is 18 years.

The initial cost of fencing is ₱150 which includes cutting and hauling posts. The posts were obtained without charge except for cutting and hauling.

Depreciation of barbed wire in pesos	₱.03
Interest in pesos	.06
Initial cost charged including cost of barbed wire	.03
Total (for 12 animals)	₱.12
Fence cost per animal	₱.01

Care of animal. The work animals of the Department of Agronomy are taken care of by one herder. With a daily wage of ₱1.00 the cost of herding one animal is ₱.09. The herder, however, takes care of the repair of the fence.

Total daily animal cost.

Depreciation and interest	₱.07
Land cost	.02
Fence cost	.01
Care	.09
Total	₱.19

DISCUSSION OF RESULTS

Single animal moldboard plows

The native and steel plows only partly turned over the furrow slice so the trash was not plowed under. The animals did not have enough plowing speed to throw over the furrow slices. The result was, that in most cases, the furrow slices fell back in their original position without being pulverized.

Of the native and the steel plow, the latter maintained a cleaner cut furrow bank. The farmer's personal preference, and his familiarity with the native implement are two factors which favor the use of the native plow.

Columns 2 and 3 of table 1 show the variation in the length of time it took to plow one hectare. It took 63.91 hours with the native plow and 64.42 hours with the steel plow. Again, the familiarity of the plowmen with the native implement was largely responsible for the difference.

These results are not far from those Henry (1929) cited. His figures for plowing one hectare were: 6 days for a man and animal working 10 hours a day making a total of 60 hours. This figure was for the first plowing only.

Reversible disc plows

As shown in columns 4 and 5 of table 1 there is a wide variation in the length of time required to plow one hectare with the two-animal single disc and with the three-animal disc plows. It took an average of 53.14 hours to plow one hectare with the two-animal single disc and 48.26 with the three-animal disc.

One of the factors which caused the wide variation was the training of both the animals and the plowmen. The bullocks had not been trained to work efficiently as a team. It required time before they could be hitched abreast and exert about equal pulls.

The third animal in the three-animal team was an added trouble to the man handling the outfit. In turning at the furrow ends, the team sometimes broke the harmony of pulling together and thus caused considerable delay in plowing the next furrow.

Reversible plows do not leave dead furrows. They pulverized the soil more efficiently than either the native or the steel moldboard plows. They are adapted to plowing grubbed and newly opened land.

Tractor plows

Columns 6 and 7 of table 1 show a narrow variation in the number of hours required to plow one hectare with tractor plows. One main factor responsible for this narrow variation was the plowing speed of the tractor which was fairly constant. Once it was set for plowing the tractor required fewer stops.

Tractor plows pulverized the soil thoroughly. Because of the plowing speed of from 3.22 to 4.83 kilometers an hour, the furrow slices were thrown about half a meter away and were turned bottom side up. A tractor plowed field presented a uniformly level surface with very little or no trash on top.

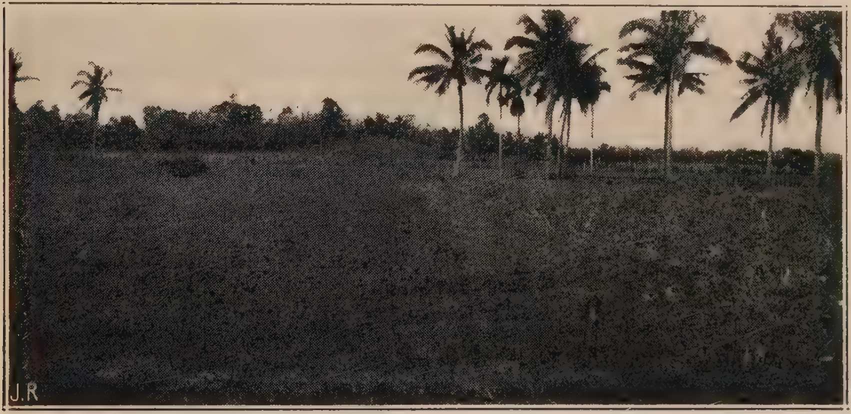

Fig. 4.—The field on the left was plowed with the tractor disc plow. Note the thorough pulverization of the soil and the covering of corn stalks. The field on the right was plowed with the native plow. The soil was not well pulverized and the corn stalks were not plowed under. Both fields had been planted to corn previous to the plowing.

Of the two tractor plows, the moldboard pulverized the soil more effectively than the disc. However, for sticky or extremely hard soil the disc gave the more satisfactory service. The construction of the disc plow warrants its use in opening new land. The small roots left after grubbing the stumps can easily be cut by the discs.

There is only a little difference between the two tractor plows in the length of time required to plow one hectare. With the disc plow it took 7.49 hours and with the moldboard plow, 8.01 hours.

Cost of plowing per hectare

Table 2 shows the interest and depreciation per hectare of the different plows used. Table 3 includes besides the depreciation and interest, the cost of labor, lubricant and tractor service.

In the same table is shown the cost of plowing per hectare. It can be observed that in plowing with the animals, there is a big difference in the cost when the animal is hired and when it is owned by the farmer. With the native plow it costs ₱15.17 per hectare when the animal is hired at ₱1.00 per day and ₱9.49 when the animal is owned by the farmer. The difference is ₱5.68. In the case of the steel plow it costs ₱15.19 per hectare when the animal is hired and ₱9.46 when owned, the difference being ₱5.73.

With use of the two-animal reversible disc plow the cost of plowing one hectare was ₱20.01 when the animals were hired and ₱10.56 when they were owned by the farmer, giving a difference of ₱9.45 in favor of owning the animal. The same result is found with the use of the three-animal reversible disc plow which gives a cost of ₱24.10 when the animals are hired and ₱11.23 when they are owned. The saving in this case is ₱12.87 when the animals are owned.

It is evident that these results show a high cost of plowing when the animals are hired. The farmers can greatly reduce the cost of farm operations involving the employment of animal labor if they can avoid hiring of work animals. These results further emphasize that farmers should own their work animals and thus lower cost of farm operations where animals are used.

In the use of the two tractor plows, there is but a little difference in the cost of plowing one hectare. With the moldboard plow it cost ₱10.35 and with the disc ₱9.80, the difference being ₱0.55 in favor of the latter. Henry (1929) stated that in the La Carlota district, Negros Occidental, the cost per hectare of medium tractor plowing with gasoline as fuel was estimated at an average of ₱12.00. This cost would have been lowered if the fuel used had been kerosene as it costs less. It will be noted, however, that this figure is not far from the results found in this study.

Comparing the costs of plowing with the use of single animal plows and tractor plows, the cost with former is very slightly lower than that of the latter when the animals are owned by the farmer. It costs ₱9.49 with the use of the native plow and ₱9.46 with the use of the steel plow. The costs of plowing with the tractor disc and moldboard plow are ₱9.80 and ₱10.35, respectively. When the animals are hired, however, it costs ₱15.17 with the native plow and ₱15.19 with the steel plow. Considering the quality of work done, it was found in the tests that two plowings with the single animal drawn plows are about equivalent to one plowing with the tractor plows (see fig. 4). This shows, therefore, that the use of tractor plows is still economical.

The use of the reversible plows was found to have the highest cost per hectare among the three types of plows tested.

SUMMARY AND CONCLUSIONS

1. The amount of work accomplished is greatly affected by the speed of plowing and constancy of work.

2. Because of a more or less constant speed and few stops in actual plowing, the length of time to plow one hectare with tractor varies little.

3. The average cost of plowing a hectare of upland soil with the native plow is ₱15.17 when the animal is hired at ₱1.00 a day and ₱9.49 when it is owned by the farmer.

4. The single animal steel moldboard plow can give a longer service than the native plow. The cost of plowing one hectare with this implement is ₱15.19 when the animal is hired and ₱9.46 when the animal is owned.

5. Although the quality of work accomplished with the reversible disc plow is much better than either the native or the single animal steel moldboard plow, its use is not recommended because of high cost of operation. It costs ₱20.01 and ₱24.10 to plow one hectare with the two-animal single 20-inch disc and the three-animal 24-inch reversible disc plow, respectively when the animals are hired at ₱1.00 a day. When the animals are owned the cost is ₱10.56 for the former and ₱11.23 for the latter.

6. The cost of farm operations involving the employment of animal labor will be greatly lowered if the animals are owned by the farmers.

7. The majority of the plowmen in the College of Agriculture prefer to use the native plow rather than the steel plow.

8. Tractor plows gave the most satisfactory results as to the quality of work accomplished. It costs ₱10.35 to plow one hectare with the two 12-inch bottom tractor moldboard plow and ₱9.80 with the two 24-inch disc plow.

9. The reversible plow is best adapted to hillside plowing where the turns at the furrow ends are difficult to make with other outfits.

10. For ordinary farm work the moldboard type of tractor plow in this test gave satisfactory results. This plow pulverized the soil very well.

11. Tractor disc plow gave satisfactory results when used in plowing sticky or extremely hard soil.

12. The tractor disc plow because of its heavy construction is recommended for use in opening new land. Because of the slicing action of the discs it easily cuts the small roots left after the stumps are grubbed out.

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TABLE 1

Variation in the number of hours to plow one hectare

CLASS RANGE	NATIVE	STEEL MOLDBOARD PLOW	TWO-ANIMAL REVERSIBLE DISC PLOW	THREE-ANIMAL REVERSIBLE DISC PLOW	TWO DISC TRACTOR PLOW	TWO BOTTOM TRACTOR MOLDBOARD PLOW
hours						
6.00— 6.50	—	—	—	—	1	1
6.60— 7.10	—	—	—	—	4	2
7.20— 7.70	—	—	—	—	39	4
7.80— 8.30	—	—	—	—	3	36
8.40— 8.90	—	—	—	—	2	6
9.00— 9.50	—	—	—	—	1	1
31.80—32.30	—	—	—	1	—	—
32.40—32.90	—	—	—	0	—	—
33.00—33.50	—	—	0	0	—	—
33.60—34.10	—	—	1	0	—	—
34.20—34.70	—	—	0	0	—	—
34.80—35.30	—	—	1	1	—	—
35.40—35.90	—	—	0	1	—	—
36.00—36.50	—	—	0	0	—	—
36.60—37.10	—	—	0	0	—	—
37.20—37.70	—	—	0	0	—	—
37.80—38.30	—	—	0	1	—	—
38.40—38.90	—	—	0	4	—	—
39.00—39.50	—	—	0	0	—	—
39.60—40.10	—	—	0	1	—	—
40.20—40.70	—	—	0	1	—	—
40.80—41.30	—	—	0	1	—	—
41.40—41.90	—	—	2	1	—	—
42.00—42.50	—	—	0	1	—	—
42.60—43.10	—	—	0	0	—	—
43.20—43.70	—	—	0	1	—	—
43.80—44.30	—	—	0	3	—	—
44.40—44.90	—	—	0	2	—	—
45.00—45.50	—	—	1	1	—	—
45.60—46.10	—	—	0	0	—	—
46.20—46.70	—	—	0	1	—	—
46.80—47.30	—	—	1	3	—	—
47.40—47.90	—	—	0	0	—	—
48.00—48.50	—	—	0	3	—	—
48.60—49.10	—	—	0	1	—	—
49.20—49.70	—	—	1	2	—	—
49.80—50.30	—	—	0	3	—	—
50.40—50.90	—	—	0	1	—	—
51.00—51.50	—	—	2	1	—	—
51.60—52.10	—	—	2	3	—	—
52.20—52.70	—	—	0	0	—	—
52.80—53.30	—	—	3	0	—	—
53.40—53.90	—	1	3	0	—	—
54.00—54.50	—	0	2	0	—	—

TABLE 1—(Continued)

Variation in the number of hours to plow one hectare

CLASS RANGE	NATIVE	STEEL MOLDBOARD PLOW	TWO-ANIMAL REVERSIBLE DISC PLOW	THREE-ANIMAL REVERSIBLE DISC PLOW	TWO DISC TRACTOR PLOW	TWO BOTTOM TRACTOR MOLDBOARD PLOW
hours						
54.60—55.10	—	0	1	2	—	—
55.20—55.70	1	0	4	1	—	—
55.80—56.30	0	2	3	1	—	—
56.40—56.90	1	1	5	1	—	—
57.00—57.50	1	1	1	0	—	—
57.60—58.10	5	3	1	0	—	—
58.20—58.70	2	2	0	2	—	—
58.80—59.30	4	1	1	0	—	—
59.40—59.90	2	0	2	0	—	—
60.00—60.50	3	3	1	1	—	—
60.60—61.10	2	3	0	1	—	—
61.20—61.70	3	2	1	0	—	—
61.80—62.30	0	1	0	0	—	—
62.40—62.90	2	3	1	0	—	—
63.00—63.50	0	0	0	0	—	—
63.60—64.10	2	2	2	0	—	—
64.20—64.70	1	2	3	1	—	—
64.80—65.30	2	0	0	1	—	—
65.40—65.90	1	2	2	0	—	—
66.00—66.50	0	0	0	0	—	—
66.60—67.10	2	2	0	0	—	—
67.20—67.70	2	1	0	0	—	—
67.80—68.30	1	5	1	0	—	—
68.40—68.90	1	1	0	0	—	—
69.00—69.50	3	2	0	1	—	—
69.60—70.10	1	1	0	—	—	—
70.20—70.70	3	2	2	—	—	—
70.80—71.30	2	2	0	—	—	—
71.40—71.90	1	1	1	—	—	—
72.00—72.50	0	1	0	—	—	—
72.60—73.10	0	0	1	—	—	—
73.20—73.70	1	1	0	—	—	—
73.80—74.30	1	2	0	—	—	—
Total	50	50	50	50	50	50
Mean	63.91 ± 0.45	+64.20 - 0.51	53.14 ±0.82	48.26 ±0.77	7.49 ±0.04	8.01 ±0.05
Standard deviation	4.77 ± 0.32	5.37 ±0.36	8.64 ±0.58	8.09 ±0.55	0.44 ±0.03	0.47 ±0.03
Coefficient of variability	7.47 ± 0.50	8.33 ±0.56	16.27 ±1.13	16.27 ±1.15	5.88 ±0.40	5.91 ±0.40

TABLE 2

Showing depreciation of plows and interest on investment per hectare

PLOWS	COST	LIFE IN YEARS	MAXIMUM NUMBER OF DAYS USED IN ONE YEAR	RATE OF INTEREST PER YEAR	NUMBER OF HOURS ACTUALLY USED	DEPRECIATION	INTEREST	DEPRECIATION AND INTEREST
	pesos			*per cent*		*pesos*	*pesos*	*pesos*
Native	17.00	4	100	10	63.91	0.30	0.03	0.33
Steel moldboard, single animal	17.00	6	100	10	64.42	0.20	0.03	0.23
Two-animal, reversible disc	175.00	8	100	10	53.14	1.31	0.28	1.59
Three-animal, reversible disc	236.00	8	100	10	48.26	1.58	0.33	1.91
Tractor two disc	347.00	8	100	10	7.49	0.36	0.08	0.44
Two bottom tractor moldboard	261.00	7	100	10	8.01	0.33	0.06	0.39

TABLE 3

Showing cost of plowing per hectare

KIND OF PLOW	USE OF ANIMAL	ANIMAL COST	LABOR COST	USE OF PLOW: DEPRECIATION AND INTEREST	USE OF TRACTOR		COST OF LUBRICANT [b]	TOTAL COST
					Depreciation and interest [a]	Supply cost		
		pesos	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Native	Hired at ₱1.00 per day	7.03	7.81	0.33				15.17
	Animal owned.	1.35	7.81	0.33				9.49
Steel moldboard	Hired at ₱1.00 per day	7.09	7.87	0.23				15.19
Single-animal	Animal owned.	1.36	7.87	0.23				9.46
Two-animal reversible disc	Hired at ₱1.00 per day	11.69	6.49	1.59			0.24	20.01
	Animals owned	2.24	6.49	1.59			0.24	10.56
Three-animal reversible disc	Hired at ₱1.00 per day	15.93	5.99	1.91			0.27	24.10
	Animals owned	3.06	5.99	1.91			0.27	11.23
Tractor two-disc			1.25	0.44	1.61	6.42	0.08	9.80
Two-bottom tractor moldboard			1.35	0.39	1.71	6.86	0.04	10.35

[a] Average life of tractors, 8 years; maximum number of days used in one year, 140.

[b] Cost of lubricant for plows only.

EFFECTS ON THE YIELD OF GRAIN AND STRAW OF RICE IF WEEDS ARE LEFT TO DECAY IN THE SOIL[1]

FERNANDO DE PERALTA
Of the Department of Plant Physiology

Between the harvest time and planting time the rice fields in the Philippines are usually thickly covered with weeds. The most effective method practiced of getting rid of them is pulling them up by hand. As this method is expensive the rice grower usually pays no attention to the weeds. In preparing fields for planting the weeds are first plowed under to rot in the soil. Whether this practice has a beneficial or harmful effect on the rice yield is not known. This study was carried out with the object of determining the effects of decayed weeds in the soil on the yield of grain and straw of lowland rice.

Weeds that grow commonly in rice fields, such as zacate (*Leersia hexandra*), water lily (*Monochoria hastata*), sedge (*Cyperus* spp.), and cogon (*Imperata cylindrica*) were gathered and planted separately in earthen pots. Later, the pots were treated as follows: (*a*) Both roots and tops of the weeds were allowed to rot in the pot; (*b*) only the roots of the weeds were allowed to rot; and (*c*) the roots and tops of the weeds were removed from the pot. This study was made during the years from 1924 to 1927.

MATERIALS AND METHODS

Clay loam soil was employed as the solid culture medium. It was taken from the Experimental Plots of the Department of Plant Physiology and was pulverized and thoroughly mixed and placed in fourteen large earthen pots, called *pilones*. Each pot contained about 28,000 cubic centimeters of soil. The cultures were placed outside of the laboratory and were numbered A-1, A-2, A-3; B-1, B-2, B-3; C-1, C-2, C-3; D-1, D-2, D-3; and E-1, and E-2. Pots A-1, A-2 and A-3 were planted with zacate (*Leersia hexandra*), pots B-1, B-2, and B-3, with water lily (*Monochoria hastata*), pots C-1, C-2, and C-3, with sedge (*Cyperus* spp.), pots D-1, D-2, and D-3, with cogon (*Imperata cylindrica*) and pots E-1, and E-2 were not planted. The last two pots served as cont ol, to show the original fertility of the soil used. The weed plants were allowed to grow from January 10 to September 7, 1924, after which time the following treatments were given: (*a*) The entire body of the weed plants, both roots and tops, grown in pots A-1, B-1, C-1, and D-1 were pulled up and were cut into pieces. These pieces were put

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[1] Experiment Station contribution No. 755. Read before the Los Baños Biological Club, July 30, 1931. Received for publication, July 15, 1931.

back in the pot after the soil in it had been thoroughly pulverized. That is, the entire body of the weeds was allowed to rot in the soil. Then, the soil was saturated with tap water. (*b*) The tops of the weed plants grown in pots A-2, B-2, C-2, and D-2 were cut off and thrown away. The roots were chopped in pieces and allowed to rot in the soil. The soil in each pot was pulverized, and later saturated with tap water. (*c*) The soil in pots A-3, B-3, C-3, and D-3 was saturated with water. Then the roots and tops of the weed plants grown therein were pulled up and thrown away. The soil was pulverized and care was taken to pull out the roots. (*d*) The soil in the control pots E-1 and E-2 was pulverized, and afterward saturated with water. Two weeks after making these preparations, the body of the weed plants turned under appeared to be fairly well rotted. Then seedlings of rice of a lowland variety were planted in the pots—six seedlings to each pot. A week later the plants in each pot were reduced to four. During the growing period of the plant, up to within a few weeks before the harvest, the soil in each culture was kept under water to a depth of from 4 to 10 centimeters. The fruiting period follows during which the soil was kept only sufficiently moist.

This set of cultures was repeated on July 24, 1926. The procedure employed and treatments given to the pot cultures were identical to the ones in the first trial,—the object being to check the results previously obtained.

RESULTS OF EXPERIMENTS

Criteria of results

The criteria employed as the basis of comparison of the nutritive or the harmful effects of the different parts of the weed plants here tested were: (*a*) Air dry weight of good grains; (*b*) air dry weight of straw; (*c*) total number of culms; (*d*) number of bearing culms; and (*e*) height of plants. The data gathered under these criteria (see tables 1 and 2) were obtained as follows:

Air dry weight of good grain. When the grain was ripe, the panicles were gathered and dried in the sun. Later, the good grains were separated from the empty and weighed on a "Cenco" balance. The data thus obtained are recorded in tables 1 and 2.

Air dry weight of straw. The straw from each culture, (not including the grains) was gathered and dried in the sun. When sufficiently dried it was weighed on a "Cenco" balance. The data thus obtained are shown in tables 1 and 2.

Total number of culms. At the time of harvest, the culms produced by the four rice seedlings planted in each pot were counted. The number of bearing culms was noted. The data gathered are recorded in tables 1 and 2.

Total height of plants. The height of the plants grown in each culture was taken after the panicles were fully exposed. Ten bearing culms, taken at random, were measured from the surface of the soil to the tip of the panicle and the average of these measurements was taken as the height of the rice plants grown in that pot. The data gathered are also given in tables 1 and 2.

Experimental data

The data obtained from the harvests of two different plantings of rice are presented in tables 1 and 2. Table 1 shows the harvest data from the first set of cultures, started on September 21, 1924, and harvested on March 5, 1925. Table 2 shows the data that were obtained from the second set of cultures, from July 24, 1926 to January 5, 1927. The numbers under the different criteria are relative values. They were obtained as follows: The harvest data obtained from the control cultures under each criterion of results here employed were given a value of 100. Using this value as the basis of computation, the actual data obtained from the other cultures under the same criterion were reduced relatively. The new values are here termed "relative value". A summary table (table 3) is also presented, to show the degree of the effect upon the yield of good grain and straw of rice plant when the whole or only a portion of the weed plant was returned to the soil previous to the planting of rice seedlings. Table 3 was constructed as follows: The relative value of good grain of rice obtained from the control culture (table 1) was subtracted from the relative value of good grain of rice obtained from pot previously grown to zacate, the entire body of which was allowed to rot in the pot. The difference 6, or 6 per cent represents the gain in rice grain of the treated culture over the control plants, or the plants that received no special treatment at all. This plan was followed also in comparing the results obtained from the treated cultures with those obtained from the control cultures, (see table 3).

DISCUSSION OF RESULTS

Beneficial effects of turning under both tops and roots of weeds to rot in the soil. Upon examination of the data in tables 1 and 2, it becomes quite evident that the yield of good grain obtained from the culture in which both tops and roots of each of the different weed plants had been grown and allowed to rot in the soil previous to planting rice was heavier than the corresponding yields obtained from the control cultures. This relationship in yields was true also for yield of straw, for total number of culms, and for number of bearing culms. In other words, the turning under of the weeds to rot in the soil before planting was beneficial to rice production both for grain and for straw. This result was to be expected, for whatever nutritive substances the weed plant had taken from the soil and used for the building of its tissues were not lost because the whole plant was allowed to rot in the soil.

Also, it is apparent from the results of the two trials (see table 3) that the relative effects of the four kinds of weeds tried were not the same. This means that although it was found beneficial to turn under weeds before planting rice, some kinds of weeds gave better effects than others. Sedge was the best, water lily the second, cogon the third and zacate the poorest.

Harmful effects of removal of tops of weeds. The relative values of the harvest data as shown in tables 1 and 2 clearly indicate that when only the roots of weeds were turned under to rot in the soil, the yield of rice either of grain or of straw was greatly reduced. The decrease of yield was so marked that when zacate roots and cogon roots were allowed to rot in the soil the yields of grain were far less than those obtained from the corresponding control cultures. But the water lily and sedge caused the rice plants to give a little better yield than the control, (see table 3). These results point out that turning under only the roots of the weeds to rot in the soil is not sufficient to insure a profitable yield. The figures under the criterion "only roots turned under" (tables 1 and 2) further show that the bulk of the material which is beneficial to the rice plant is present in the tops of the weeds. This statement is supported by the returns for water lily which gave a gain, for grain of +44 when tops and roots were turned under, and +3 gain when only roots were turned under. Also, sedge gave a gain of +60 for grain when tops and roots were turned under, and +19 when only roots were turned under. These two sets of results clearly show that the beneficial nutritive effect of the weed plants is more abundant in the tops than in the roots. These data indicate the importance of turning under the weeds, both tops and roots, in the soil to rot.

Harmful effects of complete removal of tops and roots of weeds. The grain and straw yields obtained from the plant grown in pots with the treatment, top and root of weeds removed, were in almost all cases poorer than the yield of the control plants. This result shows definitely that the removal of weeds, both tops and roots from the field, is highly detrimental to rice production. This harmful effect is due to the fact that while the weed plant was growing in the soil, its roots had absorbed some of the nutrients present in the soil, and these nutrients were thrown away with the weed, thus decreasing the fertility of the soil.

SUMMARY AND CONCLUSIONS

1. Weeds, both tops and roots, turned under and allowed to rot in the soil before planting rice plants were found to be beneficial to grain and straw production of lowland rice. Of the four kinds of weeds tried, the sedge (*Cyperus* spp.) and water lily (*Monochoria hastata*) were found to be the most beneficial, and zacate (*Leersia hexandra*) the least.
2. Allowing only the roots of weeds to rot in the soil resulted in a large reduction in yield of grain and straw of rice. When compared with the yields from the control cultures, a loss was even incurred in the culture pots where only the roots of zacate (*Leersia hexandra*) and cogon (*Imperata cylindrica*) were turned under to rot in the soil.
3. Complete removal of weeds, both tops and roots, from the soil was found to be very detrimental to rice production, especially in the pot cultures planted with zacate and cogon.
4. The nutritive values of the weed plants appear to be more abundant in the tops than in the roots.

TABLE 1

Showing harvest data as relative[a] values, obtained from pot cultures of rice, first trial.[b] Previous to the growing of rice, the culture media were grown to other plants

CULTURE NO.	TREATMENTS GIVEN TO THE POTS BEFORE GROWN TO RICE	AIR DRY WEIGHT OF good grains	AIR DRY WEIGHT OF straw	TOTAL NUMBER OF CULMS	NUMBER OF BEARING CULMS	HEIGHT
A-1	Zacate—entire body of plant allowed to rot in soil	106	105	112	110	94
A-2	Zacate—tops removed, only roots allowed to rot in soil	91	86	108	106	96
A-3	Zacate—tops and roots removed	80	81	96	89	93
B-1	Water lily—entire body of plant allowed to rot in soil	144	123	127	119	100
B-2	Water lily—tops removed, only roots allowed to rot in soil	103	116	111	103	103
B-3	Water lily—tops and roots removed	96	94	81	81	97
C-1	Sedge—entire body of plant allowed to rot in soil	160	128	173	166	108
C-2	Sedge—tops removed, only roots allowed to rot in soil	119	106	115	111	102
C-3	Sedge—tops and roots removed	99	103	104	106	99
D-1	Cogon—entire body of plant allowed to rot in soil	124	121	111	119	102
D-2	Cogon—tops removed, only roots allowed to rot in soil	97	90	108	98	104
D-3	Cogon—tops and roots removed	95	85	100	98	105
	Control—soil only (without any treatment)	100 (26.3 grams)	100 (47.4 grams)	100 (26.0)	100 (23.5)	100 (98.2 cm.)

[a] The actual values under each criterion in the control were arbitrarily taken as 100. The other actual values under the same criterion were reduced relatively.

[b] Rice seedlings were planted on September 21, 1924, and harvested on March 5, 1925.

TABLE 2

Showing relative[a] *values of harvesi data obtained from pot cultures of rice, second trial.*[b] *Previous to the growing of rice the culture media were grown to other plants*

CULTURE NO.	TREATMENTS GIVEN TO THE POTS BEFORE GROWN TO RICE	AIR DRY WEIGHT OF		TOTAL NUMBER OF CULMS	NUMBER OF BEARING CULMS	HEIGHT
		good grains	straw			
A-1	Zacate—entire body of plant allowed to rot in soil	102	114	135	133	97
A-2	Zacate—tops removed, only roots allowed to rot in soil	94	100	112	123	97
A-3	Zacate—tops and roots removed	82	86	112	102	93
B-1	Water lily—entire body of plant allowed to rot in soil	114	114	163	154	105
B-2	Water lily—tops removed, only roots allowed to rot in soil	102	111	140	144	102
B-3	Water lily—tops and roots removed	96	109	126	128	102
C-1	Sedge—entire body of plant allowed to rot in soil	112	113	121	133	102
C-2	Sedge—tops removed, only roots allowed to rot in soil	100	105	102	102	97
C-3	Sedge—tops and roots removed	90	68	102	97	92
D-1	Cogon—entire body of plant allowed to rot in soil	108	114	172	174	102
D-2	Cogon—tops removed, only roots allowed to rot in soil	95	109	186	174	102
D-3	Cogon—tops and roots removed	86	86	130	128	100
	Soil only (without any treatment)	100 (24.5 grams)	100 (35.0 grams)	100 (21.5)	100 (19.5)	100 (68.5 cm.)

[a] The actual values under each criterion in the control were arbitrarily taken as 100. The other actual values under the same ctiterion were reduced relatively.

[b] Rice seedlings were planted on July 24, 1926, and harvested on January 5, 1927.

TABLE 3

Showing relative gain or loss of grain or straw obtained from different cultures which received different treatments over control plants (without treatment)

CULTURE NO.	TREATMENTS GIVEN TO POT CULTURES	GAIN OR LOSS			
		First trial		Second trial	
		Grain	Straw	Grain	Straw
A-1	Zacate—tops and roots turned under....	+ 6.0	+ 5.0	+ 2.0	+14.0
A-2	Zacate—only roots turned under.........	− 9.0	− 14.0	−6.0	± 0.0
A-3	Zacate—tops and roots removed.........	−20.0	−19.0	−18.0	−14.0
B-1	Water lily—tops and roots turned under...	+44.0	+23.0	+14.0	+14.0
B-2	Water lily—only roots turned under......	+ 3.0	+16.0	+ 2.0	+11.0
B-3	Water lily—tops and roots removed.......	− 4.0	− 6.0	− 4.0	+ 9.0
C-1	Sedge—tops and roots turned under.......	+60.0	+28.0	+12.0	+13.0
C-2	Sedge—only roots turned under..........	+19.0	+ 6.0	±0.0	+ 5.0
C-3	Sedge—tops and roots removed...........	−1.0	+ 3.0	−10.0	−32.0
D-1	Cogon—tops and roots turned under......	+24.0	+21.0	+ 8.0	+14.0
D-2	Cogon—only roots turned under..........	−3.0	−10.0	−5.0	+ 9.0
D-3	Cogon—tops and roots removed..........	−5.0	−15.0	−14.0	−14.0

(+) Plus sign before a figure means gain over control plants.
(−) Minus sign before a figure means loss over control plants.

EXCHANGE NOTES

President Hoover gets his Vitamine C by drinking four glasses of orange juice daily, two at breakfast, one at 11 A. M. and another at 4 P. M., according to report. At this rate the Chief Executive consumes over 4000 oranges each year.

California and Florida citrus growers would like to see every person in the country follow his example, for it would mean an annual consumption of a market for 6,000,000 carloads of oranges.

Orange juice has become an important outlet for the fruit, according to a recent report of the California fruit growers Exchange. Los Angeles faced with an increasing production of Valencia, or summer oranges which are in the market in competition with other seasonable fruits, the Exchange saw the necessity of creating new outlets, and has, during the past decade, placed thousands of electrical juice extractors in cafés, fountains, hotels and clubs, backing this up with the expenditure of several millions of dollars in advertising. It was estimated that last year, 7000 carloads of oranges were used as juice. . . .

The Sunkist Junior Extractor was developed for home use in 1928. The success of this inexpensive electrical juice extractor was immediate, and more than 77,000 have been sold to date. . . .

Thousands of carloads of oranges, lemons and grapefruit are annually converted into citrus drinks by these machines and have been an important factor in increasing the per capita consumption of citrus fruits. . . At an average of 10 cents a drink, this represents a volume of fresh citrus drink business with a retail value of close to $75,000,000 annually.

—*Southern California Crops,* August 1, 1931.

A 16-ounce jar of honey, no matter how good, is hardly worth a 40,000 mile journey. Yet that is the total distance travelled by many bees to provide the nectar necessary for just that amount of honey, according to C. B. Gooderham, apiarist of the Dominion Government.

—*The Madras Agricultural Journal,* June, 1931.

The dolichos bean is finding favor in coastal counties in Southern California and as far north as San Luis Obispo. It is used as silage and forage. . . .

—*California Cultivator.*

Fifty per cent of Cuban output of sugar is obtained within a radius of ten miles of a seaport, and in the bulk of cases, the manufactured sugar is stored in the mills awaiting shipment. Where maceration is very heavy, the mills use extraneous fuel (coal or oil). Filter presses are used, but only two mills use the Petree process, which is not liked. Huge sugar pans are in use equal to 60 tons strike. On the pan-stage just a man and one boy are stationed each shift. The bulk of the Cuban molasses goes to the United States and some to Britain in tank steamers. In the factory, sugar is automatically dealt with from the fugals, and in many cases loaded into 40-ton cars which go direct to the ferry and are transported across to Key West, the ferryboat taking 40 of these cars at each trip.

There is no carting of cane in the fields beyond half a mile. . . . .

—*The Australian Sugar Journal*, June 4, 1931.

A method of destroying the nests of mound-building termites which has proved very successful in local tests is as follows and is recommended for extended trial. The mounds are first levelled to the ground if they form an obstruction which it is desired to remove. This may be effected with pickaxe and mamoty but if the mounds are large their demolition may be accelerated by blasting. A series of holes should then be driven into the area previously covered by the mound with the aid of an alavangoe, the depth of the holes being about 18 inches and their number depending upon the area concerned. In the writer's experience, the diameter of a large mound in Ceylon rarely exceeds eight feet at the base, but the average diameter may be considered to more nearly approximate half this width. As the ground has been considerably undermined little resistance will be offered to the passage of the alavangoe. One hole should be made in the centre of the area previously occupied by the mound. This operation is not always necessary as a large hole will often be found in this situation being the entrance to the ventilating flue with which most mounds are provided to supply air to the subterranean abodes of these species of termites. A circle of holes should then be made around the centre about 18 inches apart and about equidistant between the centre and the circumference of the area to be dealt with. Into each hole should then be poured, through a long-necked funnel, one ounce of petrol, the hole being immediately plugged with well-rammed soil to prevent the escape of the petrol vapour. . .

This method of treatment results in the disintegration of the fungus combs within a few days of treatment and in the trials upon which this note is founded no survivors of treated colonies have been found when the above-mentioned dosages have been applied. . . .

—*The Tropical Agriculturist*, February, 1931.

COLLEGE AND ALUMNI NOTES

Dr. Albert W. Herre, formerly head of the Division of Fisheries in the Philippine Bureau of Science, now member of faculty in Department of Biology in Leland Stanford Jr. University, addressed the student body convocation on September 5. Speaking informally, but most interestingly, Doctor Herre took his audience to some of the famous and some of the less known places in Java and other islands of Indo-Malayan region.

The College is especially favored this year by having three guest entomologists working on special problems on Campus. David T. Fullaway, Entomologist of Hawaiian Government, and attached to Board of Agriculture and Forestry is studying taro leaf-hopper parasites and pineapple insects and collecting and shipping thrips parasites to Hawaii, Dr. Irene Dobroscky is working on thrips parasites for Hawaiian Pineapple Canners. Fred. C. Hadden, Entomologist for Hawaiian Sugar Planter's Association, has been on Campus collecting and shipping parasites of insects harmful to sugar cane for several months. During August, Dr. G. A. C. Herklots, Professor of Biology in Hongkong University, was on Campus for a few weeks for purpose of giving a series of lectures in the Forest School on "The Developmental Plant Anatomy with Physiological Interpretation".

In the death on July 1, 1931 of Dr. Stephen Moulton Babcock, emeritus professor of agricultural chemistry in the University of Wisconsin, the faculty, alumni and students of this College, especially in the Animal Husbandry Department, feel that they have lost a personal friend. Doctor Babcock was known the world over for his famous Babcock Test for butter fat. His most important biological discovery was the finding of "metabolic water" liquid produced in the bodies of insects living upon perfectly dry matter.

The faculty and students lost another friend on September 5, 1931 through the death of Mr. Harry L. Comer, Superintendent of Central Luzon Agricultural School at Muñoz, Nueva Ecija. The Philippines lost a valuable teacher of agriculture. Severe burns from an accidental explosion was the cause of Mr. Comer's death.

In the first number for the year of *The Philippine Journal of Agriculture,* a quarterly published by the Bureau of Plant Industry and the Bureau of Animal Industry are articles by four graduates from this College: Vicente Aldaba, M. S. '20, Emilio K. Morada, B. Agr. '20, Aniano Elayda, B. Agr. '20 and Julian Agati, B. S. A. '23.

The Los Baños Biological Club met on August 27, 1931, at 7:30 p. m., in the lecture hall of the Department of Agricultural Chemistry of the College of Agriculture, Los Baños, Laguna.

The following papers were read and discussed:

1. "The relative efficiency of different chemical agents in bleaching buri fiber."—By Dr. F. T. Adriano and Mr. J. Banzon.

(Read by Doctor Adriano.)

2. "The effect of ethylene on the respiration of plant organs, leaves, tubers, and fruits.—By Dr. G. A. C. Herklots.

(NOTE):—Doctor Herklots is Professor of Biology in the University of Hong Kong and is editor of *The Hong Kong Naturalist*. Doctor Herklots has travelled extensively in the Far East and was engaged by the University of the Philippines to give a series of lectures in the School of Forestry on the "Developmental Plant Anatomy with physiological interpretation".

Maquiling-san", a Nagoya pullet raised at this College, now holds the annual egg record in the Philippines. She equalled the record of "Miss Aggie", the former record holder on August 25, 1931. At the end of the present poultry year, August 31, 1931, "Maquiling-san" had a record of 242 eggs to her credit. She laid 5 more eggs during the year than did "Miss Aggie", the former champion egg-layer, in 1928-1929 when she made her record of 237 eggs a year. "Maquiling-san" descended from the birds raised from the Nagoya eggs introduced by Dean Gonzalez when he returned from the Third Pacific Congress which he attended as a delegate in Tokyo in 1926. Several generations of these birds have already been produced in this College and our new champion is one of those that were raised during the season of 1929-1930. She is one of the thirteen Nagoya pullets entered by the College in the First Egg Laying Contest, 1930-1931.

Assistant Professor Anne Cole who went to the homeland by way of Europe wrote Professor Yule under date July 8 from London. An excerpt from letter follows:

> "When I reached Paris one of my first thoughts was the Colonial Exhibition. When I arrived on the grounds I went directly to the American section, and more particularly to the Philippine exhibit. I introduced myself to Doctor Faustino and Mr. Reyes both on U. P. faculty. They were very cordial and showed me around. I was exceedingly pleased with the exhibit and even prouder of it after I had seen the exhibits of other countries. Al-

though the space is small, the products are arranged with excellent judgment and are attracting no little attention. The Filipino women's dress is admired by all. In a large case are two full size women's figures standing and one man's seated. Mr. Reyes said that he felt like explaining that it is not the custom of Filipino men to be seated while women are standing. The position seemed to be necessary to show the women's dress properly. The shell fixtures are greatly admired. I had a delightful lunch with Mr. Reyes."

Miss Cole told of meeting Miss Reyes of U. P. Physical Education in Stratford-on-Avon in Shakespeare's house. She closes her letter thus: "As you have often remarked one finds nothing in scenic beauty better than the College of Agriculture offers". Miss Cole sailed for New York on July 10.

José Miguel Villegas, B. S. A. '31, died at his home in Tanauan, Leyte, July 28, 1931. With all work completed except the final revision of his thesis, illness compelled Mr. Villegas to leave College in the summer of 1929. He did not recover, but ambitious and hopeful in the second semester he registered in the College *in absentia*—and completed his thesis and was graduated with the Class of '31.

Mr. Genaro C. Bermejo, B.S.S.T. 1929 (*cum laude*), a Joaquin J. Gonzalez medallist, was appointed Instructor in Agricultural Chemistry, effective September 2, 1931. Mr. Bermejo was formerly assistant chemist in the Lopez Sugar Central and later for the Ma-ao and Barotac-Lumangas Sugar Planters Associations.

In the College Auditorium, August 29, the Dramatic Club of the University of the Philippines under the direction of Mrs. Jean G. Edades, presented the following plays. The "Far Away Princess" by Hermann Sudermann, "The Monkey's Paw" by Louis N. Parker, and "Master Patelin, the Lawyer" by Mortz Jagendors.

The Junior Prom on the evening of September 5 was a gay and festive affair. The musical selections interspersed with the dancing added to the pleasure of the party.

ON THE PALMS WHICH ARE CALLED COCOS AND THEIR GREAT USEFULNESS[1]

FRANCISCO IGNACIO ALZINA, S.J.

We can say very rightly that the coco palm is supreme among all trees, for it seems that nature and its Creator have been more especially generous with it than with the others. Almost everything is obtainable from it, and a single tree would provide all human needs, as I shall presently relate.

The coco palm overtops other trees, surpasses them in beauty, and leaves them far behind in many respects. It resembles the date palm in appearance and in size, in verdure and beauty, and in elegance of carriage and form. They differ only in the fruits, for while the date palm produces the dates which are of the size and appearance so striking to those who have seen them (they abound in Spain and much more so in the kingdom of Valencia), the coco palm produces what the Spaniards call "cocos," because the fruit, shell and meat (in which form coconut reaches Spain), has what looks like a mouth in the middle where the stem is joined and two nostril-like depressions, which because of the appearance of a frown produced, looks as if it were making grimaces (*haciendo cocos*)....

The coco palm comes to bearing much earlier than the date. In some regions it begins to set fruit five years after planting, and in others in six and at most in seven years. I have planted several thousands of these palms during my more than thirty years of residence in the Philippines; hence, I am speaking from experience in this and other points I am treating. I do not know that, as certain people claim, a male palm is necessary in order that the female may bear fruit. Even among the Filipinos[2] (as I have already recorded) there is a current belief that there are male and female palms which they recognize from the leaves. Coconuts which are planted, as is the regular practice, in large numbers and over extensive contiguous areas all produce fruit; I am unaware of such sexual distinction (as I have read from certain authors). Every month, with the new moon,

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[1] From an unpublished manuscript written in 1668 and entitled *Historia natural del sitio, fertilidad y calidad de las islas é indios*. Translated by Leopoldo B. Uichanco from a transcription of the original in Spanish which was kindly furnished by Rev. Miguel Selga, S.J., Director of the Weather Bureau. For a biographical sketch on Father Alzina, *see* THE PHILIPPINE AGRICULTURIST, Vol. XX, No. 6, (November) 1931.

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[2] The author consistently uses the word *indios* throughout the text. In translation, the terms Filipinos or natives have been substituted.

a flower stalk appears, which bursts open after twenty days or more, and uncovers the flowers. Hitherto they are inclosed in a thick hard membrane (about an arm's length and also about the thickness of an arm), and with them are some white fibers, as in the case of the dates. The inflorescence continues to open and assume the form of a plume, studded throughout with little white flowers of the size of yellow violets and equally as faintly scented. A part of their number drops, because otherwise the resulting coconuts, if they should all develop, would be too many to be nourished and brought to ripeness by the trunk.

The nuts that remain continue to develop, arranged like a tuft of feathers, until they reach the size of a round white peach. A number of the stalks proceeds to dry up until not more than ten to twelve remain, and these, together with one or two and sometimes three little nuts, continue to grow and become green until with their weight the axis which has hitherto been erect bends down and the spikes hang from it. These clusters, which the Filipinos term "rang," are now pressed against the trunk and below the bases of the petioles. Other panicles subsequently appear and behave in the same manner. In that way each palm produces twelve racemes a year, one a month, each of which has as many as ten, others up to fifteen, while a few even twenty, nuts which are very heavy. A whole year elapses from the time the panicle begins to appear and split open until the nuts are mature with the skin dry and brown. It is wonderful and pleasing to see some trees so loaded and full of nuts; one is inclined to extol the glory of God. I shall relate my experience in a town named Borongan, where near the parish house and church there were many coconut trees (and such is a common case in almost all towns). Every month I ordered all the mature nuts picked. Once I inspected a tree which looked to me to have many nuts left. I asked if that tree had already been harvested and I was answered in the affirmative and that more than thirty nuts had been brought down from it. Nevertheless, the tree still appeared so heavily loaded. I ordered some one to climb up and count the nuts that remained, so big were they and of the size they normally reached at maturity. In that one tree there were counted two hundred full-sized nuts, without taking into account the small and immature ones which were locally known as "alhoror." As young nuts, they may be peeled and cooked like the artichokes of Spain, while a certain kind may be eaten raw.

Every nut of the size we described has a loose and rather soft husk, called "bonot" (we shall deal later on with its uses); a second kind has harder covering, called "bogol" ["bagol", probably misspelled.—Tr.] which at maturity becomes black or brownish black. Within this husk is the nut proper, or shell (which in Spain is known as "coco"). When the coconut is still green, although full-sized, and this is ordinarily big and is termed "silot" locally, it contains water which is as clear as rainwater and not too sweet, so that each green nut is a water jug. It is a very cooling drink when the nut is picked before being warmed by the sun. It is very agreeable and salutary for sufferers from uraemia, although it is said to be bad for the lungs. Some nuts contain good quantities of water, others less and certain very big ones more. This coconut water comes in very handy especially in places where the water supply is not very good. I once knew a priest, who for months and even for years, had drunk nothing else and appeared to fare well (although in the beginning his stomach was somewhat upset until he got used to the water). When the water content is in the right condition, the meat of the nut is tender and relishing (I find nothing comparable to it, except certain custards which are ordinarily made from cow's milk). Upon splitting the green nut open and scooping the meat out with a thin piece of the outer husk in the same manner as with a spoon, it is a delicacy. With a regular spoon, it would not taste so good; neither would the coconut water if drunk out of a tumbler. It appears that nature has provided its own appropriate drinking cup; for, as the saying goes, wine in glass, water in earthen jug, and milk in jar, so the coconut water is drunk better and is more delicious out of its natural container, according to our daily experience.

As the coconut hardens, its meat becomes more and, thicker and, because it solidifies so much, it grows to the hard texture of an almond, although it remains firmly attached to the shell to about the thickness of a finger. When this meat is eaten out of one's hand, as some like it, it tastes like almond or chestnut, and more so if half roasted. When the meat is grated and pressed, a white, thick milk is obtained which resembles cow's milk or that of other animals and which is used here like almond milk. It is called "natuc" locally and the best luxury that the Filipinos can enjoy is a mixture of their food with this, as is largely their practice, whereby the taste is improved. The Spaniards use the milk in various dishes, particularly with rice, and the result is not inferior to those prepared with goat's or sheep's milk in Spain. Coconut milk is also used as a substitute for cow's milk in egg dishes. Grated or sliced coconut meat fattens hogs; and it has been found that with two hundred nuts freely accessible to the animals, the hogs get so fat that later on one hog would hardly eat half a nut a day. They eat the meat and on account of its oily nature they have to supplement the ration with leaves and with other fruits. From the grated meat, after sun-drying, coconut oil is made with no other effort than merely to leave it in the sun and afterwards press it. With the particular kind of press in use here, the oil comes out clear and golden, but unsuitable for food on account of the impurities which it ordinarily contains. Cooking oil is prepared by expressing the milk mentioned above, and if necessary adding a little ordinary water or coconut water itself, and then cooking in pans (of the usual kind but round like a ball beneath; these are made in China or locally from cast iron or steel; the Filipinos call these "carahay"). Oil prepared in this manner is clearer than that from sun-dried meat, as delicious as fresh oil from Spain and very acceptable for cooking anything that the latter is used for, like frying fish (although in the Philippines lard is more commonly preferred); and it has been our experience (as in the case of coconut water) that food cooked with this fresh oil is good and salutary for asthma sufferers, relief from which ailment is ordinarily obtained from its use, while copious drinking of coconut water aggravates the disease (such is the difference between parts of the same material, for the water, after the meat hardens, possesses an opposite quality to the latter; the effect of heat on the meat especially must be the principal cause of the contrast). Large quantities of oil, either cooked or raw, are prepared and used in the whole Islands, for lamps in churches and in houses, for illumination and other uses, and for various preparations.

When the ripe nut is not picked, it falls, because it becomes detached from the stem on account of lack of sufficient sap and because of the great weight (although the ripe nuts are much lighter than the green). In the ripe nut, the water contained is no longer fit for drinking (it is scanty and oily). From the eye, where it was attached to the stem, a shoot appears which grows into a palm, at first with the leaf entire and not divided, as in older palms. The fronds do not become divided until six or seven are formed. Roots are also extruded between the hard shell and the soft husk. Some way or other they nourish themselves (although hung aloft) for many days while the water condenses into an apple which grows within the nut and eventually fills the entire cavity of the shell at the expense of the meat. If the shoot be not removed before it is spent or planted or made into oil, the nut would be useless.

The white and spongy apple, which is agreeable and sweet in taste, is called "buay" or "boa". It is eaten with relish and not infrequently there is found within it (I have seen several) a white stone, more or less like a piece of crystal, of the size of an olive, some round, others elongate, and several pearl-colored, although not so fine. This stone is called "sangur" or "mutia," which is the common term for any precious stone. Certain virtues are ascribed to it; I have never verified such claims, although I have many of these stones in my possession; I do not relate them as they are just stories, but not so is the finding of the stones.

So much for the nut; let us now return to the things that may be obtained from the panicle ("fillola" in Valencia), which is the envelope and storehouse of the fruit. From it is obtained what the Filipinos and also resident Spaniards call "tuba" [toddy], which from my own standpoint, is one of the best products of that plant. The following is the manner of obtaining it: When the panicle is developed, with a length of two spans, more or less, and the thickness of an arm, before it opens or unfolds (they bind it securely if necessary), it is made to grow doubled up through great cramping. The effect is produced by tying it with one or two palm leaves to the trunk, axis, or petiole of the same palm. The process is called "buyog" which means to make yield and double up. After reaching that position (which is half arched), the Filipino begins to cut the panicle by means of a knife which is short and bent in the form of a sickle (although narrow toward the point), repeatedly renewing the cut little by little three times a day and once more at sunset. In four or five days the sap begins to flow, at first somewhat dense and turbid, but after six or seven days fluid and clear and of the color of light blue water. A bamboo tube (which is large, as we shall see) is fastened so as to receive the sap. When the plant is healthy and full of sap, and not all trees are equally so (the Filipinos can tell by the drooping leaves), about half an *azumbre*[3] may be obtained in a day from each tree, so long as the cut is renewed as described, until the entire inflorescence is used up; hence, what should have become fruits is converted into toddy. In this manner, all the substance that should go into the formation of the nuts is turned into this beverage. Other inflorescences appear, which may be used for the same purpose; so that toddy may be obtained all the year round and in all months (and not at certain seasons only, as was reported by a certain author).

Toddy is not only a delightful and salutary beverage, as has been our daily experience and as everybody knows, but also a very good medicine. It refreshes the blood, relieves inflammation of the liver, removes obstruction of the lungs, and softens a distended belly. In fact, it may be said to be a cure-all, for many who had not found any remedy for their persistent ailments secured relief from drinking toddy. When cooked to a thicker consistency, a very good and very sweet honey is made with which to prepare preserves. If left without further ado, it produces the best and strongest vinegar found here. When distilled in an alembic, as in making Spanish rum, superior wine, which is better than others used in the Islands, results (and the Spaniards and others drink it with more relish than they should) and the Filipinos, by adding certain barks of trees, without distilling, render it into a very strong wine which intoxicates them very well or very badly; because any wine or something similar affects them so.

Hence, we have in the coconut palm very clear and very good water, milk, oil, toddy (which is as good and better than mead), vinegar, and honey, all liquid; to say nothing of almonds or chestnuts, cream, artichokes and the like, apples, and precious stones. Moreover, there are the trunks, which after becoming old and no longer serviceable to the tree, may be used in building houses, the trunk furnishing all the lumber, from the posts to the other parts. From the leaves, the so called "paver" is made by doubling the pinnae lengthwise over a piece of bamboo stick and sewing them up crosswise together. This serves as shingles for the roof. Also, from the leaves are woven mats, or "petates" (as these are called here), which serve as beds; and with the exception of rattan for tying, everything may be obtained from the palm. The husk, because it is fibrous, may be made into rope; it may be used as a fuse for arquebuses, as well as for other purposes. It may be utilized for calking ships more satisfactorily than oakum from Spain, because it lasts longer and stops sea water. In the Indies a tow-rope, called "cairo," is made in large cables for the ships; these cables last longer than those from hemp or other fibers even if the latter be tarred. The hard shells are used as pots (I have often seen Filipinos cooking in them in the absence of other utensils, and if care is taken not to allow the water to boil dry, they may be used several times). They serve as dishes, called "paya," bowl and cup, called "ongot" [probably, "hoñgot. "Tr.] and mug, called "tecumates," for drinking chocolate. The trunk, as well as the petioles, and dry fruits serve as firewood (and the fire produced with it is hotter and more effective than with other fuels), and finally from the ashes, which are no longer useful for other things, lye may be made, which can be converted, by the addition of a little lime, into a very fine white and hard soap which cleanses well. For these reasons we may correctly consider (without taking into account what I shall add in the next chapter) that the coconut palm combines in it the usefulness of many trees.

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[3] *Azumbre*, a unit of measure equivalent to two liters.

ON THE AGE AND OTHER CHARACTERISTICS OF THIS PALM AND ITS VARIETIES

We shall now discuss matters in connection with other characteristics of the palm itself, inasmuch as we have already spoken at length of its fruit. We have stated that in five years the tree ordinarily comes to bearing in very favorable localities, in less suitable ones longer, but without waiting for the number of years necessary for the date palm in Spain, although the longevity of the latter is reckoned at something like two hundred years or longer. We cannot say for certain how many years the coconut lives (because the Filipinos have had and still do have very little curiosity in this regard and before our [the Spaniards'] arrival, they had not known how to reckon years and months, except that by the moon and from crop to crop they counted one year). We have seen that there are palms of which the trunks are very tall and are called "layog." Nobody remembers who planted them, although they remember the hands through which they have passed on to their present owners. These trees are so old that they have become sterile or the fruits are very small, and there can be no doubt that they must be over one hundred years old. I have learned from a certain author that in Malabar, where there are plenty of these palms, they live for three or four hundred years, so that they equal or surpass the date palm in longevity. Those that we have seen were planted by the early fathers when they founded the towns and churches and implanted Christianity (now over sixty years ago); their altars, we observed, fall far short of the ancient. Planted while young, some of the trees have come to reach a height of forty yards and sometimes more and, even at that, the Filipinos climb them as if they were climbing a stairway, because they cut notches in the trunk, in the manner of steps, which they call "lublub." [Author probably meant "laniog." Tr.] The notches are two spans distant, one series on one side and another on the other side (so as to gain successive footholds), and are two or three fingers deep, allowing space to rest the inside of the foot. The men go up and down these notches, at times carrying with them the large bamboo tubes filled with toddy and at other times bunches of fruits, with a fearlessness which taxes the admiration and almost produces a swoon among the onlookers—a sufficient test of their bravery, for they go up and down with perfect nonchalance.

I have heard some people question in the style of philosophers where the vital part is located in this palm, so long is its life. The reason for their doubts is that apparently it is not in the roots. Although many and very long, for they are found at distances of more than twenty *brazas*[4] from the trunk (the roots lengthen in proportion to the height of the trunk) and are no thicker than the little finger at their source, they progressively attenuate, although not much, and do not go deeper than about four spans (a common habit of all the trees here). We have seen many roots cut and the soil dug in other cases, without injury to the palm. The vital part is apparently not in the trunk either, for we have seen a gaping hole through it into which a closed fist would fit, without affecting the leaves, fruits, and petioles. Neither is it in the fronds, for although totally defoliated or scorched through some cause, new ones appear. The seat of life must be in the heart, which is situated in the middle; this produces the petioles or pinnae. It is a daily observation here that upon removing that part, which is done to use it for food (this is the last use made from the fresh palm), the plant dies without fail. The heart is very delicious and is cut out for food, mixed with oil and vinegar or with honey; it is incomparably better than the "palmitos" which are eaten in Spain. But boiled or stewed, it is much better and more healthful. It is prepared as pickles, or *chara*, as they call it here, which is by salting and adding vinegar; it lasts for many days and is very inviting. So that this palm is always valuable and sustaining. This palm is badly attacked by a species of beetles which is present here and which the Filipinos call "bagang" [*Oryctes rhinoceros* Linn.—Tr.]. Some of them are as big as a fist, although somewhat longer, and are of such fine blackness that they surpass the most highly burnished jet. Their skin or shell is so solid that it contains neither flesh nor blood inside and is hard like rock. Even after death, the skin lasts for months and even years without disintegrating. These beetles kill many palms because in order to reach the inner tissues on which they feed they perforate the entire tree and from the point of feeding the upper part of the frond dies irremediably. Even if all the fronds are eaten (as frequently happens), the part of the trunk that escapes sends out new shoots, but this time frequently below the heart owing to the upper part being obstructed by the drying of the petioles. Although in time the palm recovers, the trunk remains with a hump at the injured part, which remains permanently. It is in this place that life begins anew; hence, a proof that the heart is the seat of life.

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[4] *Braza,* a measure of length equivalent to about six feet.

And now that we deal with palms, we shall add other benefits derived from this palm. Between the bases of petioles (as have also the palms of Spain, although in this case they are mere trash or dolls beside giants compared with the coconuts) there is a fabric which the Filipinos call "gonot." At times it reaches a length of four spans and a width of two. It looks like a piece of Spanish burlap or sackcloth and is not less strong, probably stronger. The Filipinos use it for making bags or pockets for holding many things. Two of these serve as saddle bags for carrying food when they travel. When the rain is not heavy or too continuous, water does not drip through and wet the contents. Articles made of this material are also used as receptacles for holding clean hulled rice. Several times I have seen "gonot" used as sails of good size, for which it furnishes adequate sizes to make up the length and breadth. It is very durable and much less expensive than cloth. For all these things and more than has been said the palm is useful.

I now come to varieties of this palm that produce coconuts. Although they are all the same in the form of trunk and leaves, the latter part differs in color. Some leaves are uniformly green in the petioles, as well as in the pinnae; while in others the petioles are red and the pinnae lighter green. Still others have yellowish petioles, which are not so red as are some nor so green as are others, but midway between. The pinnae in all cases have each a small rib in the middle which is like a nerve or a vein and is very firm and tenacious. Many of them from the entire lengths of the pinnae, which are of three spans, are bundled together for use as a broom. This is the kind most commonly used in the homes of Filipinos and even of Spaniards (another use that we may add for this palm). The fruits take the color of the leaves and even the name. The red ones are called "linbahun," [probably, "lumba-um"—Tr.] which means red colored; the green "malunhao," and the lighter ones "ogis." There is also a great diversity in size, although the most common is that which we have already noted. There are very big ones which would measure more than one *azumbre*. I have heard it said (I have never seen nor measured it) that in the island of Bohol there are coconuts which measure two *azumbres*. Thus, they must be like pumpkins or large wine containers. There are others, "pilipog," which are smaller and of commonplace usage. This last kind of nuts is used for making dippers, called "tabo," for drawing water or other fluids from jars or other larger receptacles. From the smaller nuts are made "tecumates" for drinking chocolate, which are finished in a very curious and elegant fashion and which certain Spaniards embellish with silver and even with gold, each artisan adding his peculiar design. These articles are much esteemed and valued. Of the bigger nuts, bowls are made which are ornamented with gold or silver filigree, which objects, in addition to being curiosities, are believed to impart medicinal qualities to the drinking water. Persons who are afflicted with stones in the bladder are ordinarily given as a remedy drink from coconut-shell bowls.

Not only is the difference manifest in the leaves and fruits, but also in taste and in quality. There are palms which are called "cayumamis," and their fruit while tender has a sweet husk, so that it is eaten like an artichoke which it resembles much in flavor; but its water is tasteless because all the sweetness goes to the husk. However, after it grows harder, it is just like other varieties. There are also those nuts which are called "lopisán"; they have very scanty and thin husks and the meat is abundant and very thick and in this way they yield more oil than other varieties. On the other hand, other kinds are all husk, for this layer is very thick and spongy and the meat very thin. This variety is called "bontanun," and there is a saying in connection with this. When a person talks much and does little, he is called "buntanuncundao lubi"; pay no attention to that man, who is like the coconut of much husk and little meat, all words and no deeds. There are also differences in the shells; some are very thin and useless for making saucers or cups, and to these are applied the term "carahun" or "saloquihan". Certain shells are always white, others spotted with white and black, and still others very black throughout. There are also differences in the height and thickness of the trunks and of the fronds, for those that, as we said, are called "pagara" are thin and short compared with others, and those called "pilipog" are much more so, thus seeming that because of their delicate nature, their fruits would be likewise.

As to time of bearing, although, as we have stated, the coconut palm commonly begins to fruit in five or six years, there is a variety which is ready and which does produce in the third year, not because it is a dwarf (as one author claims), but because its fruiting begins early while it is small; subsequently, however, it continues to grow like the other varieties. I saw in the island of Bohol (among many other novelties) a tree of that variety which fruits very early; they call it "dailig." It was necessary to dig a deep hole in the soil in order to maintain the fruits in their natural condition. In picking the fruits one had to go into the hole and bend his body; likewise, in the collection of toddy the bamboo tubes were located below the surface of the soil and in this case it was necessary to widen the holes so that the sand would not get into the fluid. Incidentally, it should be noted that coconuts are more productive on soils which are sandy and near the sea than on harder ground in the interior. Hence, there are several islets in which these palms are most prolific and in which coconuts have grown so thick over entire land areas that all other vegetation was killed. There is such a place near Guiuan, which is called Soloan (and, according to some, this was the first Philippine soil on which Magellan set foot when he discovered the Philippines and when he first sailed through the strait that now bears his name). Soloan is so fertile and the palms there so plentiful that their trunks grow almost side by side, like fingers on a hand, although they are more widely dispersed overhead. The nuts either sprout on the palms themselves or fall to the ground and develop their shoots and roots. Thus, if certain parts of that island (in which the variety "palavan," which we spoke of above, is grown) had not been swampy, the entire place would have been covered with coconuts. Some trees so overtop the others that the nuts fall into the latter as they become detached from the trunk upon reaching maturity. One cannot easily reach that island, because it is in the middle of the mouth of a channel which passes between the islands of Ibabao and Mindanao. The current is so swift that one can cross only at certain times of the year by making "tuig," as they call it (that is, by waiting for just the right time to go there and likewise for the return trip); otherwise, one may be carried away by the current (as happens sometimes) to where he does not plan to go. The inhabitants of Guiuan prepare large quantities of oil from sun-dried coconut meat (as it is at the dry season when one can go there), sun-dried coconuts being richest in oil.

Finally, the Visayans have many names for distinguishing the ages of coconuts (I mean the fruits; the distinctive names for the plant are fewer). The newly protruding panicle is called "daot," or "tayog," which, as has been stated, takes a whole year to develop into mature nuts which are dry and are called "uga", or "lagasna." To these nuts are also applied seventeen distinct names, according to size or age. From the kind called "alhoror," which is when they may be eaten like raw artichokes until they grow dry enough to harvest they may always be used for food and various titbits may be prepared from them. Coconut oil possesses high medicinal qualities. When fresh, it is a very efficacious purgative, although one needs to have an especially good stomach to take it; and old, it is used to allay inflammations and for preparation of various ointments. It has another good property, and that is, no case is known where ill effects followed its application, as frequently happens with the use of Castille oil or of that from drug stores. For this reason, it may be said of this oil that from its effectiveness against certain pains and inflammations it has as much medicinal value as the toddy which we have discussed above.

And in conclusion, in order to leave nothing to be said about the coconut, I might add that by slightly enlarging the largest eye in the shell (which in the natural state hardly admits the little finger), it serves as a trap for monkeys (which are very keen-witted and seem like rational beings or at least they must possess a vestige of reason). The way is (for the curious) to set one, two, or more of these especially prepared nuts containing a certain amount of their own meat, which is much relished by the monkeys (they even steal the toddy from the collecting tubes), as well as coconut water, when they can, and this may be done when the fruit is still green. The monkeys insert their hands through the holes, which they can easily do, to get at the little loose pieces of coconut meat. After preliminary trials, they bring out the meat piece by piece and eat it. They soon gain enough confidence and upon inserting the hands again, reach down so deep that they are unable to withdraw them from the tight-fitting opening. Not wishing to let go of the booty, they remain prisoners, so that although they wanted to flee, they could not do so owing to the weight of the coconuts. They are held by the load and are captured and killed, for not wishing to abandon what they once started to do.

The coconut is not a bait for monkeys only but also for men who often steal the nuts. And may what happened to me once serve as a warning! In the town of Tacloban (capital of the province of Leyte, where the *alcalde mayor* ordinarily lives) we had a number of palms from which we could hardly obtain nuts, because the natives of the town, as well as strangers, and worse perhaps the domestics of Spaniards (who always have bad habits here) would not leave us a single fruit. I was a recent arrival in that town and I told them in the church one Sunday that it was wicked to steal the coconuts, and more so, because they belonged to the church and therefore were like sacred things; and that if they needed any nut, they should come to me and I would give them some, but to make this possible it would be necessary that they do not steal them all. There was, however, very little change, until God finally used an effective means. One evening a native came to steal coconuts. He climbed a palm which was six or seven *estados*[5] in height. It was not one of the oldest, having been planted by the *padres*. He grasped a frond or branch in each hand in order to mount the tree and pick nuts. But his precaution was of no avail. Both petioles tore off from the trunk (a rare happening when the petioles are green, and never seen hitherto) and fell along with him to the ground where he died without being able to say even an "ay". (There was a house nearby occupied by the caretaker of the coconuts and the people there heard the impact unaccompanied by any other sound.) He was found in the morning with the two petioles in the grip of both hands and these were released only by the use of force. Hence, it seems as if the palms of the hands fused with the palms of the tree. They notified me. I was sorry for the mishap and we buried the dead. But every one regarded it as a punishment from God and thereafter, in twelve and a half years that I stayed in that town, nobody dared to approach the coconuts, so frightened were they at that event. As a proof of its efficacy, the *alcalde mayor* once related to me that many months after the tragedy, he offered a native one *toston*[6] to fetch some green nuts but he refused saying that he would not climb those palms for ten pesos because God was watching over those palms of the *padre* and that he did not wish to get killed like the other fellow. So much for coconut palms; let us take up other subjects.

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[5] *Estado,* a measure of length equivalent to 1.85 yards.

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[6] Portuguese silver coin.

ESSAY ON THE BANANA

(*A Japanese schoolboy on the "honorable" banana*)

The banana are a great remarkable fruit. He are constructed in the same architectural style as the honorable sausage. Difference being skin of sausage are habitually consumed, while it are not advisable to eat rapping of banana.

Perhaps are also intrissing the following differences between the two objects. Banana are held aloft while consuming, sausage are usually left in reclining position. Banana are first green in culler, then gradual turn yellowish. Sausage start out with indefinite culler (resemble terrier cotta) and retain same hue indefinitely. Sausage depend for creation upon human being or stuffing machine, while banana are pristine product of honorable mother nature. Both article resemble the other in that neither have pit or colonel of any kind.

In case of sausage both conclusions are attached to other sausages, honorable banana on opposite hand are joined on one end to the stem, other termination are entirely loose.

Finally, banana are strictly member of the vegetable kingdom, while affiliation of sausage is often undecided.

—*Christian Science Monitor.*
Reprinted in *The Poultry Item.*

President Emeritus Thompson of Ohio tells a story about a student who was taking an exam. He couldn't answer the last question. He thought that the professor was a pretty good friend of his, so he wrote "Only God could answer that question. Merry Christmas." The professor wrote back "God gets a hundred; you get zero. Happy New Year."

—*What the Colleges are Doing.*

CASSAVA GROWING AND CASSAVA STARCH MANUFACTURE[1]

NEMESIO B. MENDIOLA
Of the Department of Agronomy

WITH TWELVE TEXT FIGURES

Realizing the possibilities of the cassava crop in this country the College of Agriculture at Los Baños began the study of cassava culture and the industry very early in its history. Foreign varieties have been imported and tried, analyses made of the storage root, plant breeding work performed to produce new types, different methods of storage of roots tested, appliances devised for extracting the starch, the possibility of the starch as a source of alcohol studied, and recently experiments on the value of cassava as a hog feed have been run. When the author spent a year in Java, he had an opportunity to study the cassava industry in that country. The knowledge he obtained there combined with the experimental data which have been gathered in this College during the last twenty years places this institution in a position to meet the demand which has increased lately for information about this crop. In the past we have received numerous visits from what we may call cassava prospectors and have answered many inquiries about the culture of the plant and the manufacture of cassava starch. To facilitate our service to the public, this circular is issued. Questions regarding points not covered in this paper, will, it is needless to say, be gladly answered.

HISTORY AND GEOGRAPHICAL DISTRIBUTION

There is much of interest to students of cassava in the history and distribution of this plant. For the purposes of this circular, however, very little will be given on this subject. Interested readers will have to refer to other, more exhaustive publications.

According to authorities, the cassava was known as a cultivated plant by the natives of Brazil, Guiana and South Mexico before the discovery of America. Its culture is important in the following countries: Brazil, Guiana, Peru, Jamaica, Mozambique, Madagascar, Réunion, Malacca and Java. The so called native cassava must have been introduced from Mexico into the Philippines during the early Spanish régime. Commercial varieties, however, were not introduced until after the close of Spanish rule. At present, the cassava plant is found growing in all parts of the Philippines.

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[1] Experiment Station contribution No. 758. Circular No. 21. Received for publication, October 1, 1931.

THE CASSAVA PLANT

Botanically, the cassava plant is known as *Manihot utilissima* Pohl. Certain authors confine this name to the bitter varieties and use *Manihot palmata*, var. *Aipi* to refer to the sweet kinds. It belongs to the family Euphorbiaceae. Commonly, it is called cassava. It is also called tapioca and manioc. The word tapioca, however, is more often used to denote certain market forms of cassava products.

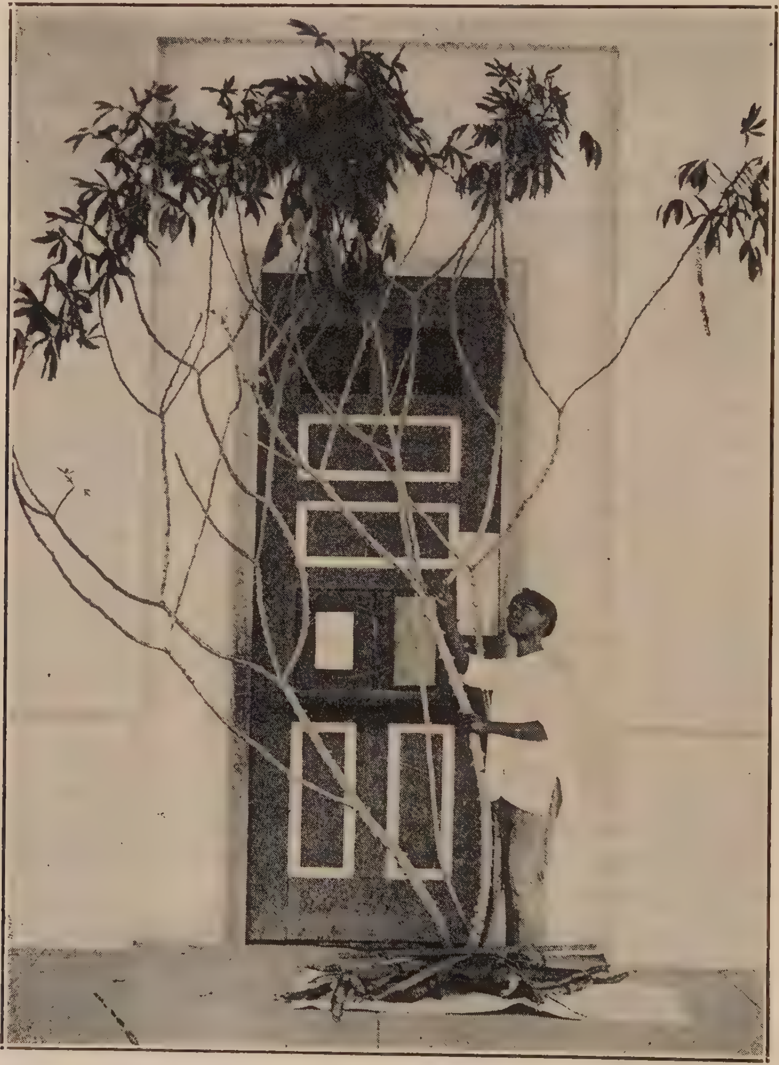

Fig. 1.—A mature cassava plant, 11 months old. The storage roots covered a circular area about a meter in diameter. This plant yielded 11.29 kilograms of roots.

In the Philippines, there are several native names for the cassava. Among these, *camoteng cahoy*, meaning tree sweet potato, is probably the most important. Other names are *camoteng moro* and *balinhoy*.

The cassava plant (see figure 1) is a perennial shrub which if allowed to grow indefinitely reaches the size of a small tree. At the age of about a year, when it is usually harvested, it is from two to three meters high. The stem, which varies in color from pale or dirty white to brown, is marked by numerous internodes formed by the scars left by the fallen leaves. The leaves are palmate, pale to dark green in color with about five to nine lobes. There is a variety used for ornamental purposes the leaves of which have yellowish or white areas at the center of the lobes; another variety is very conspicuous because of its curly leaves. The petiole varies from pale white to pink in color.

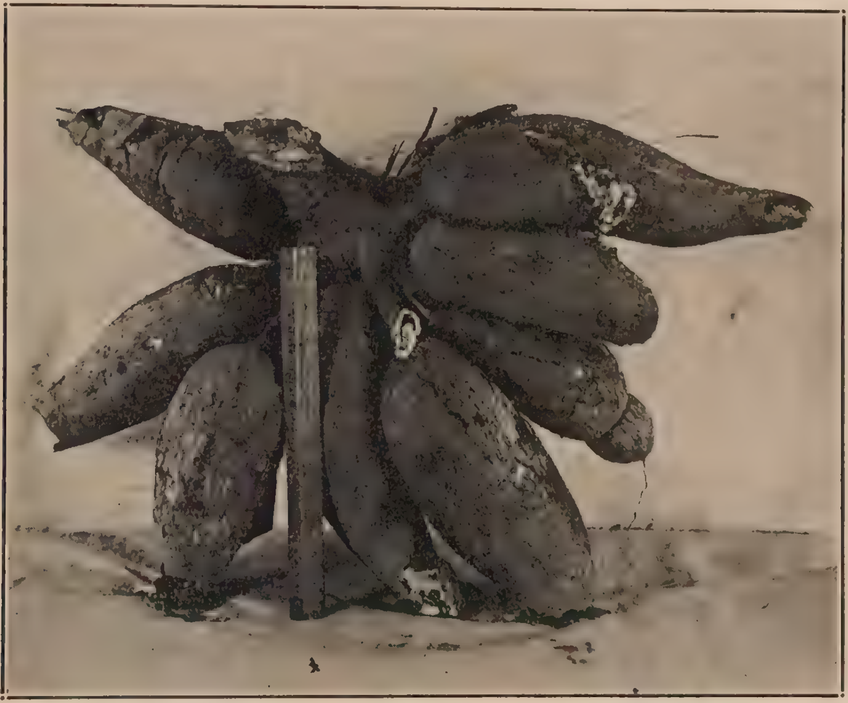

Fig. 2.—A close view of storage roots of a cassava plant 13 months old. The roots weighed 12.08 kilograms excluding attachments to the stem of the plant.

The roots of the cassava plant are few and shallow and some of them are metamorphosed into storage roots. (See figure 2.) It is for these roots which may contain from 15 to 40 per cent of starch that this plant is cultivated. These storage roots vary in number, shape, size and weight mostly because of varietal differences. Among the varieties studied at

Los Baños, the average number of roots per plant was found to be from 3 to 5 and the average length of roots of the one-year old plant, from 27.7 cm. to 43.3 cm. and diameter, from 4.6 cm. to 7.4 cm. Under conditions exceptionally favorable to the plant, a single root may weigh 4 kgm. and all the roots of a plant may weigh 12 kgm. The storage roots are generally clustered around the base of the plant, and extend on all sides about 60 cm. Some roots tend to grow deep. In this paper, unless otherwise specified, the word "root" or "roots" used with reference to cassava, will refer to the storage roots.

The chemical composition of cassava is of interest to the planter, the starch manufacturer and cassava consumer. Adriano and his co-workers (1931) performed a number of analyses of different varieties of cassava grown in this College Their results are summarized in table 1. Referring to the hydrocyanic acid, the poison found in the bark and flesh of the cassava roots, it is said that a dose of 50 to 60 mgm. is fatal to a person of average weight and that weaker persons may succumb to a smaller dose. It should be remembered that in boiling the cassava roots much of the acid is evaporated, while in the extraction of starch, it is removed in the process of washing.

TABLE 1

Average proximate chemical composition of some varieties of cassava

COMPOSITION	PERCENTAGE
Edible portion	81.40
Moisture	63.80
Ash	1.44
Proteins	0.96
Fats, Ether Extract	0.26
Hydrocyanic acid	0.02
Crude fiber	0.85
Starch	27.65
Other N. F. E.	5.04
Calorific value per kgm.	1403.00

VARIETIES

There are many cultivated varieties of cassava. In Java about twenty-five are considered important. In the Philippines only one or two are of wide distribution and these are so called native varieties, which are simply varieties which have been grown for a long time here. One of these old varieties is called Balinhoy. Others have been known in our records as Rough Intermediate, White Smooth Intermediate, Kapo White and Kapo

Colorado. The old varieties produce comparatively small roots and a low yield but these are fairly sweet and are suitable for food purposes. This College has introduced from time to time different foreign varieties, and if cassava growing is ever to attain a prominent place in Philippine agriculture, some of these introduced varieties will have to be grown. The foreign varieties which have been tested and found high yielding in this College and which have been distributed in different parts of the Philippines are called Mandioca Sao Pedro Preto, Mandioca Basiorao, Aipin Mangi, Aipin Valenca, and Cassava Singkong Manis. Through seed propagation many new varieties have been produced some of which promise to supplant some of the old standard varieties. The new varieties which are produced through seed propagation are usually known as seedling varieties and distinguished from other varieties by bearing numbers instead of names. This College has produced many seedling varieties, but the greatest number have been produced in Java. The College seedling varieties which have been found good yielders have been designated as seedlings 1, 2, 3, 4, 5, and 6 (previously called Unite, Magsino, Agati, Baker, Salinas, and José, respectively.) Seedlings Nos. 1 and 2 were derived from variety Aipin Mangi while Nos. 4, 5, and 6 were from Mandioca Basiorao.

In 1927, the author personally brought from Buitenzorg, Java, the following varieties and seedlings, which are known to be the best yielders in that country: Aipin Trapecuma, Mandioca Itaparica, Mandioca Tapicuru, Mandioca Criolinha, Aipin Manteiga and Seedling varieties, Nos. 239, 1964, 2152, 2159, 2536, 3718, 3795, 3886. These seedling varieties were produced by the Plant Breeding Division of the General Agricultural Experiment Station of Java under Mr. Koch, from whom also the other recently imported varieties were received. The yield of the varieties listed above, except those bearing numbers as names, is given in table 3. Seedlings Nos. 239, 3718, 3795 and 3886 came from the parent Mandioca Sao Pedro Preto and are supposed to be better yielders than this variety.

Cassava varieties have also been classified into the sweet and bitter groups. The bitter cassavas usually have more hydrocyanic acid compound than the sweet.

For example, it was found in Trinidad, British West Indies, that in the sweet cassavas, the percentage of hydrocyanic acid compound in the bark of the root was from 0.014 to 0.042 per cent and in the edible portion, from 0.003 to 0.015 per cent. In the bitter cassavas, the variation was from 0.012 to 0.056 per cent in the bark and from 0.013 to 0.037 per cent in the edible portion.

Table 2 gives information on the relative poisonous nature of different varieties now found in the Philippines and also their comparative flavor after boiling.

TABLE 2

Quality of roots of different cassava varieties in the Philippines after boiling

VARIETY	POISONOUS NATURE AFTER COOKING	FLAVOR
Mandioca Sao Pedro Preto	Very poisonous	Not edible
Mandioca Basiorao	Not poisonous	Fair
Aipin Mangi	Not poisonous	Very good
Aipin Valenca	Not poisonous	Good
Casjave Singkong Manis	Not poisonous	Very good
Kapo White	Not poisonous	Good
Kapo Colorado	Not poisonous	Fair
Rough Intermediate	Not poisonous	Good
White Smooth Intermediate	Not poisonous	Good
Aipin Trapecuma	Not poisonous	Good
Mandioca Itaparica	Not poisonous	Good
Mandioca Tapicuru	Not poisonous	Fair
Mandioca Criolinha	Poisonous	Not edible
Aipin Manteiga	Not poisonous	Good

TABLE 3

Yield of different varieties of cassava[a]

VARIETY NAME	YIELD AT COLLEGE OF AGRICULTURE PER HA. AT AGE OF			JAVA FIGURES[b]			
	10 months	11 months	12 months	Yield of roots with skin per Ha.	Yield of peeled roots per Ha.	Percentage of starch in peeled roots	Yield of starch per Ha.
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*	*kgm.*
Mandioca Sao Pedro Preto	27,880	37,180	38,500	44,789	38,205	31.2	11,920
Mandioca Basiorao	36,060	37,780	38,820	——	——	——	——
Aipin Mangi	19,200	22,620	35,700	38,099	32,270	36.8	11,875
Aipin Valenca	18,320	20,320	20,970	37,582	31,606	37.5	11,852
Casjave Singkong Manis	12,980	15,120	16,140	38,035	33,775	32.9	11,111
Kapo White	11,260	11,740	15,220	——	——	——	——
Kapo Colorado	7,140	9,960	10,840	——	——	——	——
Rough Intermediate	10,640	13,280	14,320	——	——	——	——
White Smooth Intermediate	8,640	12,360	12,300	——	——	——	——
Aipin Trapecuma	——	——	——	43,383	37,915	32.8	12,436
Mandioca Itaparica	——	——	——	36,311	31,554	36.2	11,423
Mandioca Tapicuru	——	——	——	42,756	34,333	32.7	11,227
Mandioca Criolinha	——	——	——	43,474	36,736	29.6	10,874
Aipin Manteiga	——	——	——	38,650	33,123	31.5	10,434

[a] Philippine data, according to Sison, (1921).

[b] Van der Veer (1926).

It should be remembered that even a good efficient factory gets only about 18-20 per cent of the starch of fresh roots with skin which amount represents 70 per cent of the amount of starch present in the cassava. The portion removed from the roots in peeling them off represents about 15 per cent of the fresh weight.

The important cassava varieties found in the College cultures may be described as follows:

Mandioca Sao Pedro Preto. This variety is not tall growing and in this respect it is similar to Aipin Manteiga. Its most distinguishing characteristic is the conspicuous brownish red color of the skin of the old portion of the stem near the roots. The young unfolding leaves are hairy on the upper side; petiole of young leaves, hairy; unopened leaves, light green; leaf veins and midrib, light green with pink patches; leaf petiole, dark red above, dark green below; tender part of stem, green; skin of old stem, brownish red; leaf scars of young stem, green with reddish brown patches: skin of root, brownish red; bark of the root, white; ratio of greatest breadth to length of main lobe of a fully developed leaf 1:3 to 1:4.

Mandioca Basiorao. Young unfolding leaves, hairy on the upper side; petiole of young leaf, hairy; unopened leaves, light green; leaf veins, light green with pink patches; midrib, light green; leaf petiole, patches of green, rose and brownish red, both on the upper and the lower sides; tender part of stem, green; skin of old stem, brown; leaf scar of young stem, red and light green; skin of the root, brown; bark of the root, white; ratio of breadth to length of leaf lobe, 1:4.

Mandioca Itaparica. Upper side of young unfolding leaves, hairy; petiole of young leaf hairy; unopened leaves, light green with pink tinge; leaf veins and midrib, light green with pink patches; petiole of mature leaf, light green with pink patches above, light green below; tender part of stem, green; skin of old stem, light brown; leaf scars, brown; skin of root, dark brown; bark of root, white with brown tinge; ratio of width to length of main lobe of leaf, 1:3–1/3.

Mandioca Tapicuru. Upper side of young unfolding leaves, hairy; petiole of young leaf, hairless; unopened leaves, purple; leaf veins and midrib, light green with red patches; petiole of mature leaf, light red above, light green below; tender part of stem, greenish purple; skin of old stem, brown; leaf scars, light brown with green borders; skin of root, brown; bark of root, white with light brown stripes; ratio of width to length of main lobe of leaf, 1:3–1/5.

Mandioca Criolinha. Upper side of unfolding leaves, hairy; petiole of young leaf, hairless; unopened leaves, brown to light purple; leaf veins and midrib, red center, distal light green with red patches; petiole of mature leaf, dark red all over; tender part of stem, red with green stripes; skin of old stem, brown; leaf scars, brown with light red borders; skin of root, brown; bark of root, light brown; ratio of width to length of main lobe of leaf, 1:5–1/5.

Aipin Mangi. Upper side of unfolding leaves, hairy; petiole of young leaf, hairless; unopened leaves, light green with light brown tinge; leaf veins and midrib, light green; petiole of mature leaf, green with red patches above, green below; tender part of stem green; skin of old stem, brown; leaf scars, brown; skin of storage root, dark brown; bark of root, pink; ratio of width to length of main lobe of leaf 1:8.

Aipin Trapecuma. Upper side of unfolding leaves, hairy; petiole of young leaf, slightly hairy; unopened leaves, brownish green; leaf veins and midrib, light red to pink, center distal green; petiole of mature leaf, dark red above, greenish red below; tender part of stem, green with red patches; skin of old stem, brown; leaf scars, brown with red borders; skin of root, dark brown; bark of root, white; proportion of width to length of main lobe of leaf, 1:4.

Aipin Valenca. Upper side of unfolding leaves, hairy; petiole of young leaf, hairless; unopened leaves, light green with light brown tinge; leaf veins and midrib, center red, distal green with red patches; petiole of mature leaf, dark red all over; tender part of stem, green with brown patches; skin of old stem, light brown; leaf scars, brown with light red borders; skin of root, brown; bark of root, pink; ratio of width to length of main lobe of leaf, 1:3–1/2.

Aipin Manteiga. Upper side of unopened leaves, hairy; petiole of young leaf, hairy; unopened leaves, light green; leaf veins and midrib, light green; petiole of mature leaf, green with red stripes above, light green below; tender part of stem, green; skin of old stem, greenish brown; leaf scars, brown; skin of root, dark brown; bark of root, white with light brown tinge; ratio of width to length of main lobe of leaf, 1:4.

Casjave Singkong Manis. Upper side of unopened leaves, hairy; petiole of young leaf, hairy; unopened leaves, light green with light brown tinge; leaf veins and midrib, light green with pink patches; petiole of mature leaf, light green with pink patches above, light green below; tender part of stem, reddish brown; leaf scars, reddish brown; skin of root, dark brown; bark of root, white with brown patches; ratio of width to length of main lobe of leaf, 1:1–1/5.

The many growers who have secured cassava cuttings from this College for planting are cautioned not to mix varieties in the field as such a practice might under certain conditions prevent them from knowing the comparative value of these varieties. Consequently, they could not select the very best ones, which should be the aim of every grower.

Comparison of varieties may be based not only on yield of roots and starch per hectare but also on earliness of production, ease of harvesting and other cultural points which affect the cost of production. Good yield and ease of harvesting are two very vitally important characters to be desired.

The terms *early* and *late* have been used to describe varieties of cassava. Used in this way, these terms do not have the same meaning as when applied to rice or maize. By an early variety of cassava is meant one which at its young age gives a better yield than at its older age. By a late variety is meant one that gives a better yield at its older age than at its younger.

CLIMATE AND SOIL

The cassava is a purely tropical and sub-tropical plant. Attempts to acclimatize it outside the sub-tropical belts have failed. The plant does well in a warm moist climate. According to certain authorities this crop thrives profitably up to an elevation of about 845 meters above sea level. In Java it is considered inadvisable to grow the cassava above an elevation of 1500 meters. The cassava plant will grow in most kinds of soil, provided the soil is not water-logged. Whether it is profitable to grow it in all kinds of soil is entirely a different matter. The best soil for cassava is one which is light, sandy and well aërated and drained. The roots tend to decay in water-logged soils. Newly cleared lands are exceptionally good for cassava. If the land has been planted previously to other exhausting crops as sugar cane, rice and corn, manuring may have to be resorted to.

CULTURE

If a farmer expects to grow cassava on a large scale profitably, he will have to do it in a business-like way, use the high yielding varieties, prepare his land properly, use good cuttings, cultivate his field, etc. He will have little or no profit if he follows the shiftless condemnable method of carelessly sticking his cassava cuttings in anywhere and then forgetting all about his cassava plants until harvest time.

Propagation. The cassava plant is commercially propagated by cuttings. Sections about 25 cm. long of mature, but not too old, stems may conveniently be used for commercial planting. In case of a shortage of propagating material, old and young stems and even stumps may be used, but for large scale culture this is not advisable. The propagating materials can be multiplied very rapidly by planting them in a nursery where they may be cut back after they have grown about a meter high. The cuttings thus obtained can be planted again in the nursery and be treated as the parent plants.

The results of experiments and experience in Java suggest the following recommendations in planting. After removing the young top portion of the stem which is not good to use as planting material, the remaining part may be cut into pieces 25 to 30 cm. long. There is no advantage gained in using longer cuttings. The bottom pieces seem to be better than the middle ones and these in turn better than the upper cuttings. The stems are cut into pieces only shortly before planting. If they are to be kept for a fairly long time or to be shipped over long distances, the cut surfaces of the top and bottom of the bundles are coated with tar and the stems are preserved in bundles standing in a dry, dark cool place without being cut into planting pieces. When they are to be planted, the bundles are transported to the field and sawed into pieces of the desired length. (See figure 3.) Pieces prepared more than ten days before planting should not be used. In sawing, care is taken not to cause splitting of the top end of the sticks. Sticks with forked top or with developed vegetative buds should not be planted.

The ground is plowed two or three times, followed each time by harrowing. The furrows are laid one meter apart. The planting material consisting of cuttings made of fairly mature stems is placed in holes about 75 cm. to one meter apart, one stick in each hole. Poor soils allow closer planting than rich ones. The stick may be laid in a slanting position, as is the practice of the common farmer, making an angle of about 45° with the surface of the soil or it may be planted in a vertical position. The sticks are covered with soil, leaving only 3 to 5 cm. of the top end uncovered. Sticks should not be planted upside down, as this will cause low yield.

Weeding and cultivation. Cultivation begins when the plants are about one-half meter high. Every month thereafter for three months, weeding should be done. When the plants have grown to about one meter high, hilling should be done gradually. After this, the plants may be left unweeded, for a dense shade will have been formed by the leaves above the ground preventing to a large extent the growth of weeds. (See figure 4.) Likewise, no cultivation is necessary after the hilling is done because any disturbance of the soil near the base of the plants may seriously disturb the development of the storage roots.

WHEN TO HARVEST

Ordinarily the roots may be harvested when the plants are 10 to 14 months old. Between 10 and 14 months there is an interval of 4 months. It will be necessary at times to estimate the yield of a standing cassava field at a given time either to have an idea of its yield for purposes of sale or at intervals of one month to determine if the maximum yield is already obtainable. To estimate the yield of a field it is recommended that every tenth row be sampled, harvesting plants from every tenth hill in each tenth row and determining the yield. If a tenth hill be vacant, it should be counted as if there were plants there. From the yield obtained from the number of hills harvested the yield of the total number of hills in the field may be estimated. When the yield is no longer increasing the field is at the proper age to harvest. A delay in harvesting such a field may mean decreasing the yield.

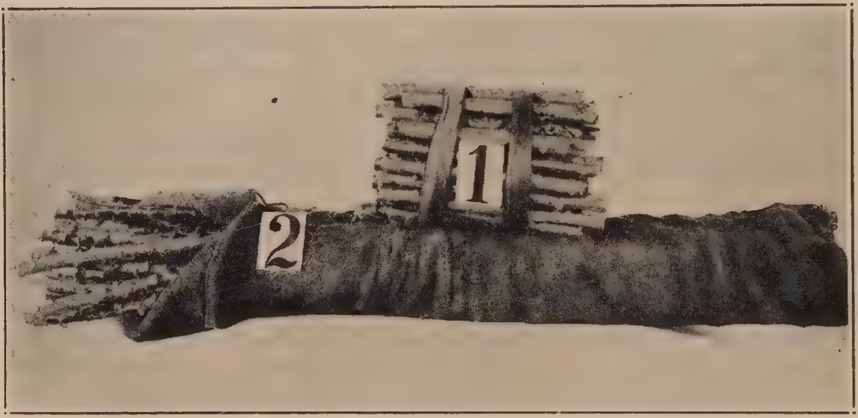

Fig. 3.—Cassava cuttings. (1) Cut for planting; (2) for long distance shipment. Banana bracts may be used instead of old sacks for wrapping the cuttings for shipment.

HARVESTING

Unlike other root crops, as sweet potato, which may be harvested by shallow plowing, cassava requires more careful attention in harvesting.

The storage roots are long and delicate. They spread around the base of the stem thus making the passage of a plow nearer than 60 cm. undesirable as the tubers will be broken and the contents soiled. Also the careless use of a spading fork or any other digging implement will damage some of the storage roots.

It has been the practice in this College in harvesting to cut the stem first, leaving a portion of the base of the plant to serve as a handle to pull up the storage roots. If the soil remains soft up to this time, the pulling of the base of the plant is comparatively easy, and most of the storage roots come up with the stem. A piece of strong bamboo pole stuck into the soil below the roots and used as a lever will facilitate the uprooting of the plant. Whether the use of this will pay or not will have to be determined by individual growers under their respective conditions. Harvesting is the most expensive item in the production of cassava, and how to lower this item is a serious problem now before cassava growers. Experiments are under way in this College to determine the use of a plow for harvesting and the possibility of thus lowering cost of production.

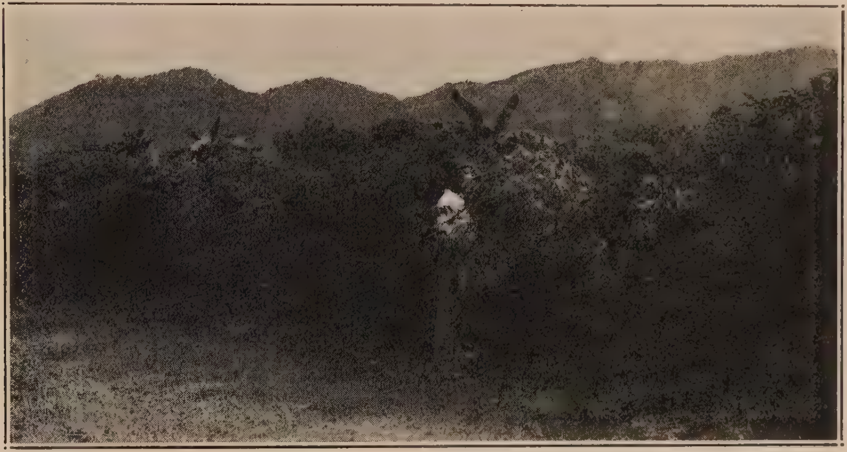

Fig. 4.—A field of cassava plants four months old. At this age the ground is practically all shaded with the plants.

After harvesting it is advisable to use the roots immediately or within 24 hours, for at the end of this time the roots begin to deteriorate rapidly. It is advisable to harvest daily only as much roots as can be milled within 24 hours. Unwashed roots keep longer than washed ones. If the roots are to be peeled the peeling should be done just before the roots are milled or otherwise used.

YIELD

The yield of a cassava planting is discussed under the topic "Varieties" and data are shown in table 3. The figures in this table show that the best yield of the native varieties is only about 15,220 kgm. of roots per hectare, while the foreign varieties yield from 16,140 to 38,820 kgm. And the yield of the same varieties in Java offer some hope that even higher yields than these could be expected under the right cultural conditions. Exceptional yields of 5.0 to 5.5 tons per hectare have been obtained in Java with the variety Mandioca Sao Pedro Preto. Considering these yields, the planting of native varieties is to be discouraged. They have the added disadvantage that they are comparatively more fibrous than the imported varieties.

FALLOWING, MANURING AND FERTILIZATION

Experience in other countries furnishes both a suggestion and a guide in matters of soil treatment to maintain or increase yield of cassava roots.

Cassava is considered a very exhausting crop and it is said that it can not be grown profitably three successive years in the same field.

Javanese cassava growers fallow their land for one or two years after several harvests of this crop. The application of a phosphate fertilizer at the rate of 560 kgm. per hectare is said to have doubled the yield in a field in Hawaii. In another case it is reported that an application of 280 kgm. per hectare of a fertilizer containing 2.6 per cent phosphoric acid, 3 per cent nitrogen and 5 per cent potash increased the yield by 6,227 kgm. per hectare. In Buitenzorg, Java[2] in laterite soil, green manuring using cassava variety Mandioca Criolinha and green manure plant, *Crotalaria anagyroides* HBK., increased the yield by 5594 kgm. of roots per hectare. When the use of this green manure was supplemented with the application of 870 kgm. of lime-marl per hectare the yield was increased by 9878 kgm. of roots per hectare. Liming alone increased the yield per hectare by 4508 kgm.

Other experiments with green manuring showed about the same effect on yield.

DISEASES AND PESTS

Practically, cassava is free from the attack of serious plant diseases and pests in the field. Its worst enemy in the Philippines is the hog. There is but one protection against this animal and that is to fence the plantation.

USES OF CASSAVA

As source of starch. (See figure 5.) The most important use of cassava is as a source of starch. The process of extracting starch from the cassava roots is described in continuation in this circular. As sold in the market this starch is not pure. Its composition is as shown in table 4.

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[2] Koch, L. en M. van der Meer. 1926. Uitkomsten van eenige bemestings-proeven met cassave. Korte Berichten uitgaande van het Algemeen Proefstation voor den Landbouw. No. 50.

TABLE 4

Composition of market cassava starch (Van der Veer, 1926)

(Dr. De Jong)

Component	*Percentage*	*Component*	*Percentage*
Water	13.5	Glucose	9.15
Ash	0.1	Starch	81.25
Protein	0.6	Fat	0.4
Crude fiber	trace		

There are three grades of starch. Starch of the first grade comes to the market pure white, odorless and with such fine particles that upon rubbing a small sample between the fingers, it produces small crackling sound. According to those who have measured these particles, they are about 3 to 20 microns in diameter.

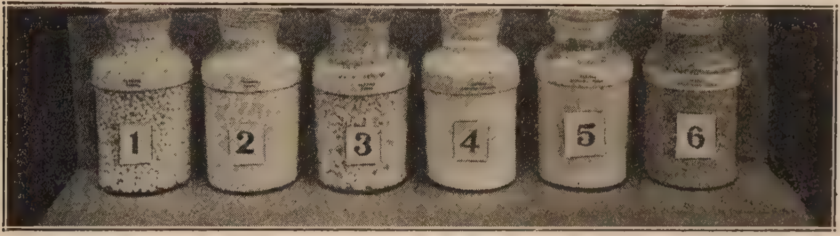


Fig. 5.—Samples of cassava products produced and sold in Java.
(1) pearl, (2) seed, (3) flake, (4) first class starch, (5) inferior starch and (6) ground waste (ampas).

The different cassava starch products which are important articles of commerce and with which both the starch manufactures and consumers should be familiar are the *flakes*, *siftings*, and *pearls*. Of the pearls, there are three forms,—the medium pearl, the small pearl and the seed pearl. These starch products are usually used for human food.

Briefly, tapioca flakes are prepared by heating the moist starch, obtained after the third "sinking" process in the starch manufacture, on thin plates or in flat iron pans. The pearls are prepared by "squeezing, rolling or shaking the moist starch into round pellets. These pellets are then rolled or made to fall into an iron plate or table, which is also shaken and the temperature of which is about 100°C." After heating, the starch turns gelatinous in appearance and becomes partly soluble in water.

As source of gaplek. "Gaplek" is a Malay word used to designate dried peeled roots of cassava. Gaplek is a very important article of export from Dutch East Indies. It is produced mostly by the natives of Middle and East Java. Gaplek is prepared as follows: After peeling the root, it is cut lengthwise and crosswise into four pieces. Each piece is in turn divided into three or four pieces depending on the length of the piece. These pieces are dried in the sun. After five or six days, or maybe longer, they are ready for export. Sometimes, the peeled roots are cut into thin slices and then placed in clean running water to remove the slimy covering before they are dried. Materials prepared this way are said to become moldy easily, especially when they are not thoroughly dried.

Gaplek has been exported from Java to Europe for a long time. It is there used in the manufacture of cheap industrial alcohol and low grade starch. The United States and Japan have also been importing gaplek from Java in recent years.

For direct human consumption. An idea of the food value of cassava may be obtained from the composition of the root as shown in table 1. Table 5 gives additional information on this point and shows comparison of cassava as food with rice.

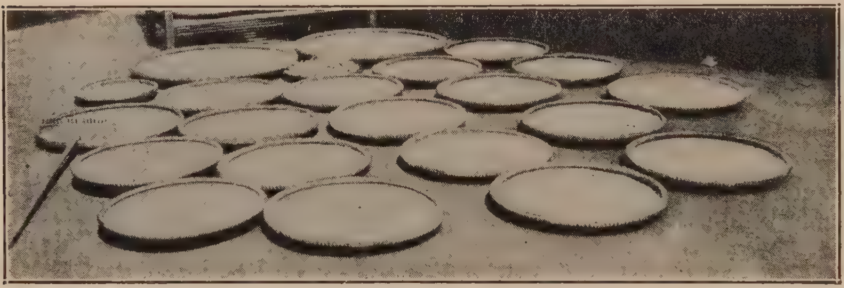


Fig. 6.—Cassava products being dried in the sun in shallow bamboo baskets (bilao).

TABLE 5

Composition of dry cassava storage root compared with rice

COMPONENT PARTS	STORAGE ROOT OF CASSAVA[a]	ROUGH RICE[b]
	per cent	*per cent*
Moisture	5.76	13.58
Ether extract	0.42	2.18
Crude fiber	5.08	6.34
Pentosan	2.63	——
Starch	64.28	67.24 (carbohydrates)
Protein	2.98	6.26
Ash	1.96	4.45
All others	16.89	——

[a] According to Tracy (1903).
[b] According to Santos and Adriano (1929).

According to Nichols (1929) grated cassava has always formed a great portion of the diet of the natives of Guiana, New Granada, Brazil and Peru. It is there eaten in the form of meal and bread.

In the Philippines, cassava roots are used for food occasionally. When used for food, it is of course, advisable to avoid using roots of the bitter varieties, especially those of Mandioca Sao Pedro Preto and Mandioca Criolinha. Also, only freshly harvested roots should be used. It is said that as an antidote to cassava poisoning, red pepper dipped in rum is used by the natives of Guiana. In case of poisoning a physician should, of course, be called immediately. There are three popular ways of preparing the root for food. One is to boil it after removing the bark; a second is to peel it, then grate into cassava *meal* and then cook by steaming; the third is to make the grated meal into native cookies called *suman*. In cooking, care is taken to allow the steam to escape as with it any poisonous gas from the roots will also pass. When used as food, the boiled cassava root or meal is usually eaten with grated meat of the coconut fruit. In preparing the meal for food it is advisable to squeeze it first to get rid of its liquid which contains some of the poisonous substance of the root. Cassava meal may be stored after it is dried to be used later as food.

The cassava roots, after peeling, may be chopped into thin slices, washed thoroughly, dried and then stored. The dried *chopped roots* may be used later in the same way as the dried meal.

The dried *cassava meal* or *dried chopped roots* may be ground into fine powder and sifted, producing a dull white cassava flour. This flour may be used in the preparation of various foods, preferably in combination with wheat flour.

Cassava as feed for live stock. While cassava growers in the Philippines know that hogs are one of the worst enemies of their cassava crops, as they miss no chance to get into a cassava field and dig and eat the roots, the use of the roots for live stock feed has not become general. According to Tracy (1903), however, the cassava root is fed to horses, mules, milk cows, fattening cattle, hogs and poultry, all of which relish and thrive upon it. The same author says cassava has a feeding value equal to silage in stimulating the flow of milk in milch cow, that it imparts a very rich color to the milk, and that it is a very good feed for fattening show animals, including cattle and poultry.

When used as feed, only the so called sweet varieties are used as these contain less hydrocyanic acid poison than the bitter kinds. The roots after removing the bark, may be fed, chopped or grated, fresh or dry. When in dry condition, the chopped roots and meal are fed mixed with water.

While the cassava root may be fed to animals alone, studies made in this College by Dr. Mariano Mondoñedo and his students show that the cassava is not as concentrated a food as other live stock feeds and that it will be more profitable to use it in combination with other materials. For instance, they found that feeding hogs three parts of peeled cooked cassava which is equivalent to two parts of raw cassava, had about the same feeding value as one part of Native Yellow Flint corn.

Mondoñedo and Bayan (1927) in comparing the feeding value of cassava with corn, fed for 70 days two lots of weanling pigs on sweet potatoes with one of the lots receiving a ration made up of 40 parts corn, 40 parts rice bran, 15 parts copra meal, and 5 parts shrimps, and the other receiving the same ration except that 20 parts of the corn used in the first lot was replaced by 40 parts cooked and peeled cassava (2 parts cassava is assumed as the equivalent of 1 part corn). The corn lot made an average daily gain per pig of 0.214 kgm. and required 2.9 kgm. feed to make a one kgm. gain. Whereas, the pigs in the cassava lot made an average daily gain of 0.206 kgm. and required only 2.65 kgm. feed for every kgm. gain.

In feeding the same rations to the same pigs in dry lot for the next 70 days the corn lot made an average daily gain of 0.138 kgm. requiring 6.84 kgm. feed for a kgm. gain in weight. The cassava lot made an average gain of 0.175 kgm. requiring only 6.52 kgm. feed in order to gain a kgm. in weight.

In another set of experiments where 30 parts shelled corn or ground corn were each replaced by 60 parts cassava in conjunction with 50 parts rice bran and 20 parts copra meal and fed to 9 months old barrows in dry lot, the pigs made an average daily gain of 0.326 kgm. The ground corn lot gained daily 0.336 kgm. and the shelled corn lot 0.327 kgm. The cassava lot required 6.46 kgm., the ground corn 6.30 kgm. and the shelled corn lot 6.49 kgm. feed to make one kgm. gain.

Based on the amount of feed required to make a kgm. gain, 2.2 parts cassava when fed under the conditions of the first two trials and 2 parts cassava under the condition of the third test were equivalent to 1 part corn.

Mondoñedo (1928) fed a lot of 8 months old pigs in dry lot a ration of 20 parts corn, 70 parts rice bran, 8 parts copra meal and 2 parts shrimps. Another lot was fed a similar ration, except that the corn was replaced by raw unpeeled chopped cassava (again 2 parts cassava was assumed as equivalent to 1 part corn). The corn lot made an average daily gain of 0.364 kgm. and the cassava lot 0.394 kgm. The corn lot required 4.32 kgm. feed and the cassava lot 4.76 kgm. to make one kgm. gain. Taking the amount of feed consumed to make a unit of gain, 2 parts cassava is 80 per cent as efficient as one part corn, or 2.5 parts cassava is equivalent to 1 part corn.

Mondoñedo and Alonte (1931) in determining the feeding value of cassava, pongapong (*Amorphophalus campanulatus* (Roxb) Blume ex Deene) and sweet potato roots compared with corn, fed in dry lot for 140 days a lot of 7 ten-kgm. weanling Berkjala pigs a feed mixture made up of 25 parts corn, 50 parts rice bran and 25 parts copra meal. Three other lots were similarly fed except that the corn in their rations was entirely replaced by 50 parts of cassava, pongapong, or sweet potato in cooked form. These investigators reported that from the point of view of rate of gains made, the cassava and sweet potato lots averaged 90 per cent as efficient as corn, and the pongapong lot, 70 per cent. The corn lot required 7.07 kgm., the cassava lot 9.27 kgm., the sweet potato lot 8.64 kgm. and the pongapong lot 9.80 kgm. feed to produce one kgm. gain in weight. Based on feed required to make a kgm. gain, cassava was 66, and sweet potato, 61 and pongapong 69 per cent as efficient as one part corn. In other words, under the conditions of the trial, 3 parts cassava or sweet potato, and 3.6 parts pongapong are equivalent to one part corn. An important by-product obtained in the manufacture of starch is the cassava bagasse. It is known in Dutch East Indies trade as *ampas*. The cassava bagasse is composed of the root fibers of cassava and a small percentage of starch and other root constituents left after most of the starch has been extracted from the roots. This waste product may be fed to animals. Of course, its feed value is quite low and so it is usually fed in combination with other feeds.

Other uses of cassava. The cassava root may be used as a source of *alcohol* and *alcoholic drinks.* According to Nichols, (1929) natives of Guiana and neighboring countries manufacture from the root an intoxicating drink called *piwarri.* It appears that fresh roots, as well as dried roots in the form of cassava meal, gaplek and bagasse may be used for this purpose. The liquid squeezed out of cassava meal when heated and reduced to syrup consistency becomes what is called *cassareep.* This product is said to be a very powerful antiseptic and is used in preserving all kinds of meat in a fresh condition for considerable periods. It is also said to be the basis of many well known sauces.

Uses of the stem and pith of the cassava plant. The stem of the plant when not used for propagation may be dried and used as fuel. It is important to take this point into consideration in running large factories where artificial drying of starch is a regular phase of the work. The dried pith of the stem of the cassava plant is used by the Filipinos in the preparation of decorative curtains. The pith is cut into pieces about three millimeters thick and then strung sideways. A group of the strings of the pieces of cassava pith when arranged linearly form a beautiful curtain, especially when the pieces of pith have been dyed various bright colors.

MANUFACTURE OF STARCH FROM CASSAVA

Starch may be extracted from cassava on a small scale for home use or on a large scale in a factory.

Extraction as a home industry. The simplest device that can be used for this purpose consists of a piece of plain galvanized iron in which holes have been punched, mounted on a small block of wood, with the rough edges of the holes pointing upwards. This device forms a coarse grater. To use it, the cassava roots are peeled with a sharp bolo and then washed carefully to remove any soil particles. If the peeled roots are not to be grated at once they should be submerged in water to prevent the formation of a dark coating on the peeled material. If this dark coating appears it must be removed before grating as it will cause the starch to be grayish in color instead of white.

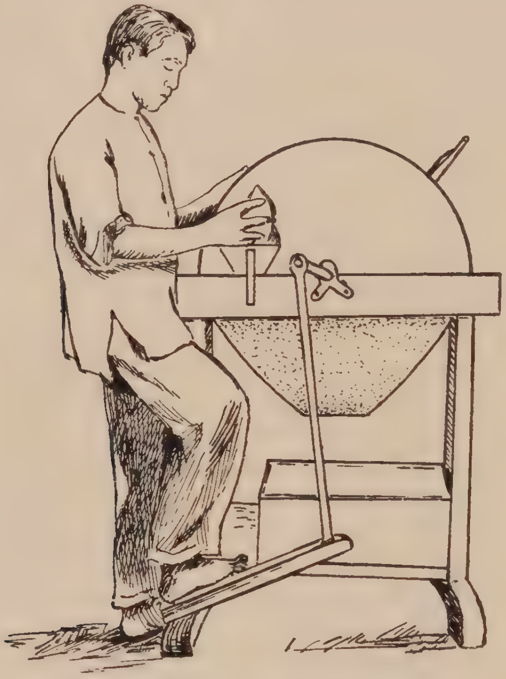


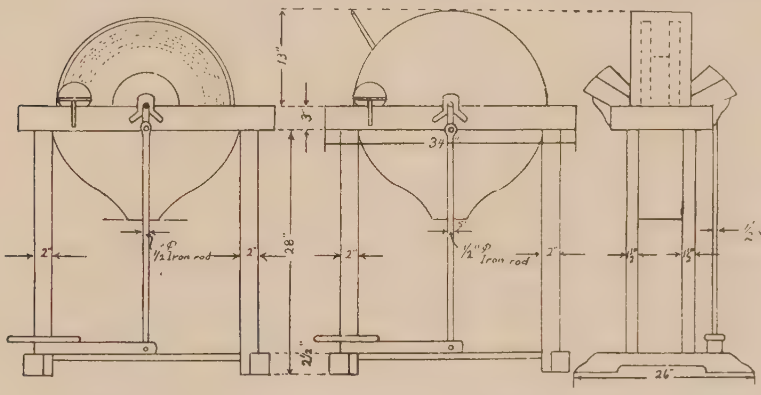
Fig. 7.—A view of College Cassava Grater No. 1.

The roots are crushed by rasping them against the sharp edges of the holes of the grater. The grated material is called cassava meal.

The cassava meal is placed in a clean container,—it may be a basin or petroleum can,—water is added to double the volume of the original material and the mixture is stirred vigorously. It is then strained through ordinary muslin cloth into another clean container. The cassava meal may be ground in a mortar and washed and strained two or three times, so as to remove as much as possible the starch content. The strained liquids, or filtrate are combined and allowed to settle. In about 15 minutes the water may be poured off. The material that settles is the starch. As to color and cleanliness the starch is yet not the best, for in most cases it is still dirty. To produce the really white starch, this material should be subjected to at least two or more washings, each time using a volume of water about five times the volume of the starch, settling and pouring off of water to follow each washing. After the last straining, or filtering the starch is removed from the container and placed in shallow bamboo baskets and dried either in the sun or with artificial heat (fig. 6).

The starch should be dried thoroughly and uniformly. When spread 5 to 10 mm. thick on the drying containers, the wet starch will dry in from 12 to 36 hours exposure to sun, depending on the intensity of the sunlight and the humidity of the air. In the process of drying it is necessary to turn over the starch occasionally that it may dry uniformly.

Starch is dried artificially either in an oven, when there is only a small amount of it or, as in large factories, in a room through which heated air circulates. Here the temperature may be raised to about 50°C. To prevent coloring, smoke is never allowed to come in contact with the starch.



SIDE VIEW WITHOUT COVER SIDE VIEW WITH COVER END VIEW

Fig. 8.—A plan of College Cassava Grater No. 1.

The dried starch is in the form of lumps and before it is placed in the market it is powdered by grinding. The dried starch should be kept in dry containers or in dry rooms.

The College of Agriculture has devised two small portable machines which may be used in the home for the extraction of cassava starch and which may be inspected in the Department of Agronomy of this institution. These machines are for convenience called College Cassava Graters No. 1 and No. 2. They may be ordered at this College. The price is ₱30 each f.o.b. College Station, Laguna. No. 1 (see fig. 7 and 8) devised by Mr. Zozimo Montemayor, formerly of this College, may be described briefly as follows (Montemayor, 1929): The grater is in the form of a wheel with punched surfaces of 1.5 mm. on one side and 2.5 mm. on the other side. A piece of board outside covers the wheel and prevents the cassava meal from flying out. Each side of the grater is provided with a feeder. The cassava meal drops by gravity, passes through an opening provided below, and goes into a receptable. Operation is accomplished in the fashion of a sewing machine, with the feet providing the power and the hands feeding the grater.

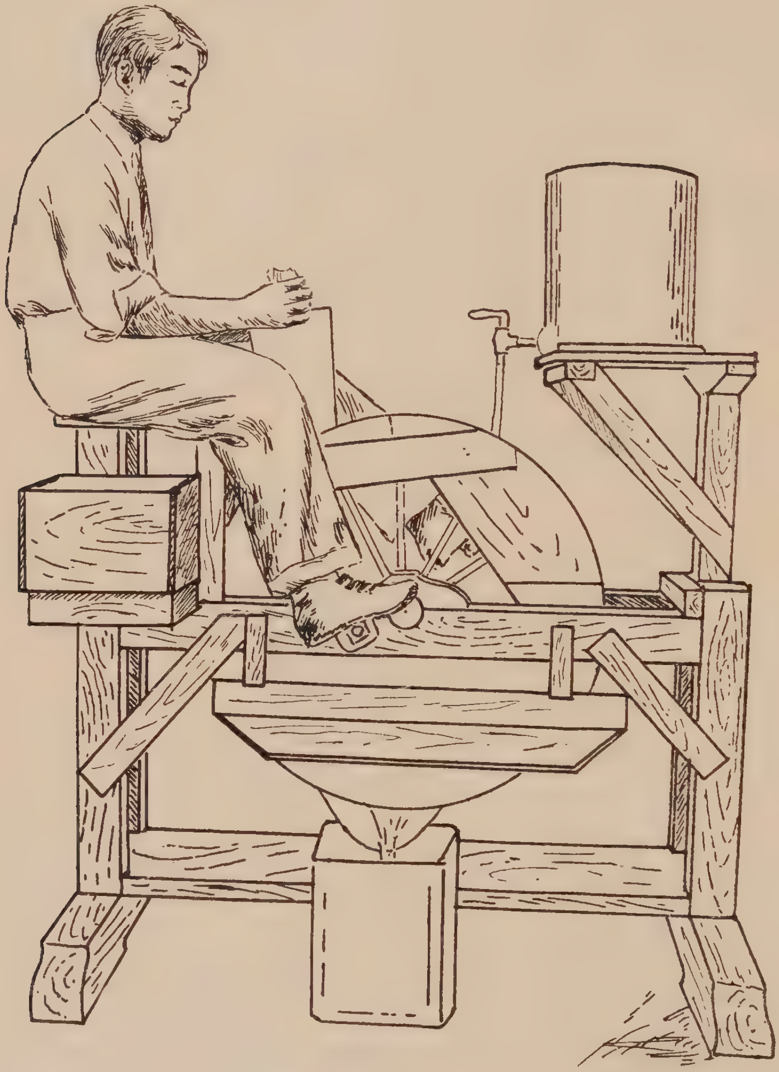


Fig. 9.—A view of College Cassava Grater No. 2.

The vertical wood piece at the center is the lever attached to a sort of treadle for the feet. With this device grating is done very much faster than with the native appliances. Grater No. 1 has a grating capacity of 12-24 kgm. of roots per hour depending on the operator. Grater No. 2 (see fig. 9 and

10) devised by the author and patterned after a grater used in Java, is constructed on about the same principle as No. 1 except that the teeth of the grater are formed not on the sides of the revolving wheel but on the periphery and instead of being operated in the fashion of a sewing machine, it is operated like a bicycle. It has about the same capacity as No. 1.

Extraction on a factory scale. For this purpose there are machines for sale in Manila. These machines range in capacity up to 10 tons of fresh roots daily, of 24 hours run. Those interested should obtain information from the agents for these machines in the city. The following are some of the different machines which have been advertised:

1. Uhland Manioc Starch Machinery
   Capacity—1200 to 1500 kilograms of fresh roots in 10 hours.
   Price—₱5,244.00 f. o. b. Manila
   Distributors—Philippine Engineering Company, 936 Raon Street, Manila, with branches in Cebu and Iloilo.
2. Starch Making Machinery (Uhland System)
   Capacity—1000 to 1300 kilograms of dry cassava starch in 10 hours.
   Price—₱23,500 f. o. b. Manila.
   Distributors—Pacific Commercial Company, Manila.
3. Adt. Starch Making Machinery (Hand Operated)
   Capacity—1500 to 2000 pounds of roots in 10 hours.
   Price—₱900.00 f. o. b. Manila.
   Distributors—Fred Wilson and Co., Inc., 53-55 Barraca Street, Manila.
4. Adt. Starch Making Machinery (Engine Operated)
   Capacity—5000 to 6000 pounds of roots in 10 hours.
   Price—₱1100.00 f. o. b. Manila.
   Distributors—Fred Wilson and Co., Inc., 53-55 Barraca Street, Manila.

In addition to these machines, the College of Agriculture has another device, the Cuzner machine, named in honor of Professor Harold Cuzner who devised it. (See figures 11 and 12.) This machine works on the same principle as the College portable graters described, only the power is provided by a 3-horsepower engine, instead of by human energy, and it is provided with an oscillating sieve which operates at the same time as the grating cylinder. The Cuzner machine can extract starch representing about 15 per cent of the peeled roots. With better quality of roots this figure may be raised. The number of different operations required in the extraction of starch with the Cuzner machine is much less than with large machinery, but its efficiency is less.

To those who might be inclined to devise their own machines it is suggested that in the last analysis the extraction of starch from the cassava or similar roots consists in breaking the starch cells and separating the starch from the cell walls and other constituents of the roots by washing and subsequently drying the starch to separate the water. A device that will break the greatest number of cells in the least time should be the aim in making cassava starch extracting machines. Hence the principal part of such machines is the grater or rasper which has projected teeth. As the starch cells are very small, are microscopic in fact, the finer the teeth of a machine the more individual cells it will break in a given length of time. About one mm. should be the height of the teeth of the grater.

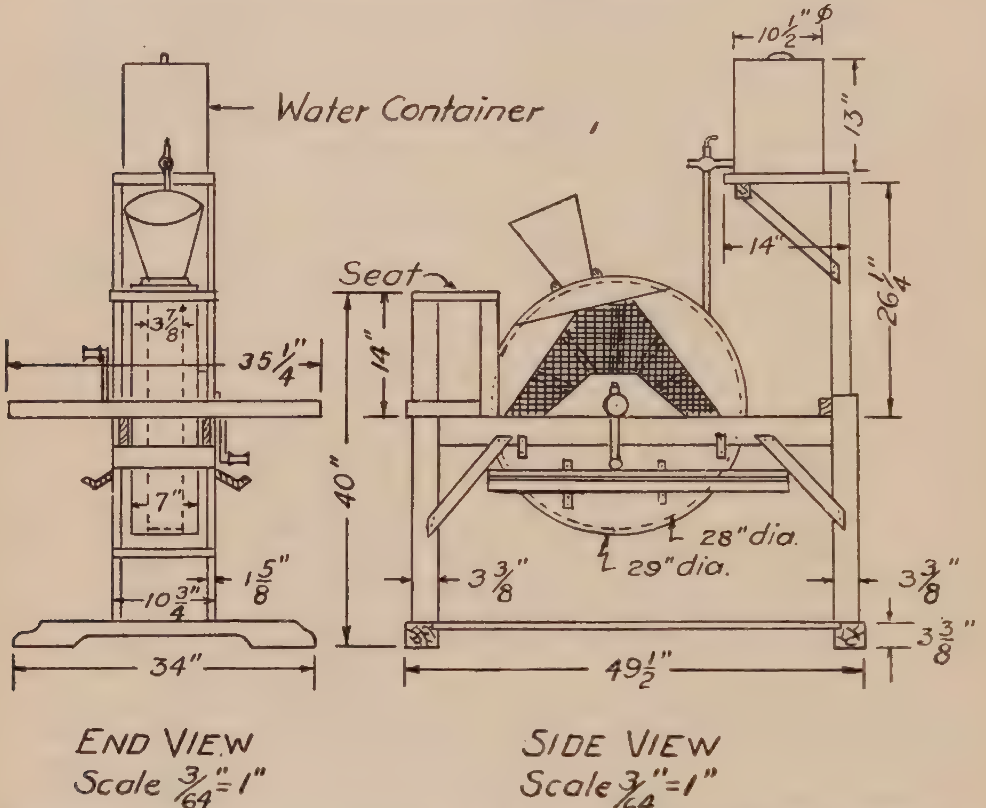


Fig. 10.—A plan of Grater No. 2 (prepared by Mr. E. N. Bautista of the Engineering Department).

The different steps in the extraction of starch in a regular large factory are, according to Van der Veer (1926), as follows:

1. *Roots received.* Should not be more than 24 hours out of the ground.
2. *Washing of the roots.* The least bit of dirt that goes with the root through the mill may color the starch gray. Hence, in the washing, brushes are sometimes used.
3. *Peeling.* Should be done very thoroughly to be followed by rasping or grating within 24 hours.
4. *Grating, or rasping.* The object of this operation is to break the starch cells. Cylindrical raspers are used mostly, and sprinkled with water so the mixture of starch and water may run into a tank.
5. From this tank the mixture is pumped up into another tank which is above the sieve. In this tank it is stirred thoroughly.

6. *Sieving.* From the second tank the mixture is allowed to flow into a metal sieve with a relatively large mesh. The filtrate goes through a finer sieve and then into a third tank while the materials not passing through are again rasped or milled and then sieved again.

7. *Sinking.* While the filtrate is being emptied into the third tank, it is constantly stirred by a couple of stirring devices. After this tank is full, the stirring stops, the stirring apparatus is removed, and the liquid allowed to stand for 12 hours. The starch settles down to the bottom and the clear water is decanted.

8. *Mixing.* After decanting the water in the sinking tank, water is again added so that the increase in depth amounts to 15 to 20 cm. Then the stirring apparatus is again allowed to work; the thoroughly mixed liquid goes into a mixing tank wherein the liquid is stirred while water is being added, to make a uniform mass.

9. *Sieving.* The liquid from the mixing tank is passed through a very fine sieve, while water is being added. The remnant is again worked as before.

10. *Sinking.* The starch water passing through the sieve is led to a series of canals, 20 meters long and about 1 meter wide—with an inclination of about 2-3 mm. per meter of length. Here, the starch sinks while the water flows down. Any impurity noticed in here is removed with a small paint brush.

11. *Mixing.* The sediment in the preceding sinking canals is transferred to a mixing tank where it is mixed throughly with water, the mixing lasting about one hour.

12. *Sinking.* After mixing, the liquid is poured into the sinking tank. What fails to settle here after seven hours is allowed to go into a second sinking tank. What fails to sink in the second tank is poured into a third sinking tank.

The starch from the first tank is later converted into the best kind of flake; from the second tank, into the second class flake; and from the bottom of the third into the first class starch, while from the surface, into the second class starch. From the water drained from the three last sinking tanks, a third class starch, which is grayish, is obtained.

13. *Centrifuging.* The different grades of starch are separately freed from the greatest quantity of water by centrifuge, which breaks the lumps at the same time.

14. *Drying.* The grades not destined for flake preparation are dried, either artificially or in the sun. If artificially, care is taken not to raise the temperature too much.

15. *Powdering.* Fresh from the drier, the starch is usually in lumps. A discriminating market would classify this as low grade. Therefore, it is necessary that the dried starch be ground into powder form. After grinding the starch it is sieved to separate the coarse from the fine particles.

16. *Classifying or sorting.*

17. *Sacking.* The starch is finally placed in sacks of about a picul capacity.

As may be understood from the steps listed above, plenty of water is necessary in starch manufacture. The use of water from rivers and streams is much cheaper than the use of water which has to be pumped from of an artesian well. For economy in the use of water, the places where the operations are performed which necessitate the use of water should be at a lower elevation than the waterpipe conduit. Sometimes water is encountered which colors the starch. This property of water is supposed to be due to its content of ferro bicarbonate. Water containing this may be purified by aëration, that is by allowing it to form a spring or shower in the sun before it is used.

FIGURES FOR THE CASSAVA BUSINESS

Cost of production and selling price of cassava roots. Assuming a yield of 25,000 kgm. of roots per hectare, the cost of producing, including harvesting, a kgm. of roots in this College will be about ₱0.02 the first year, if the cuttings used are bought at about 5 centavos a meter, and ₱0.01 thereafter or when the cuttings planted are obtained gratis. Considering these costs it is probably unfair to the planters to be offered only ₱0.01 per kgm. for their roots. At least for the farmer to break even, the cost of transportation should be added to this offered price.

In Java it is estimated that the production cost is about ₱0.009 a kgm. at Buitenzorg. It should be remembered, however, that the price of labor in that country is very much lower and the yield of cassava much higher than in the Philippines. At Batavia, which is reached after about one hour's ride in the train from Buitenzorg, cassava was selling recently at ₱0.04 a kgm. This is the retail price asked by this College for cassava roots produced on the College Farm.

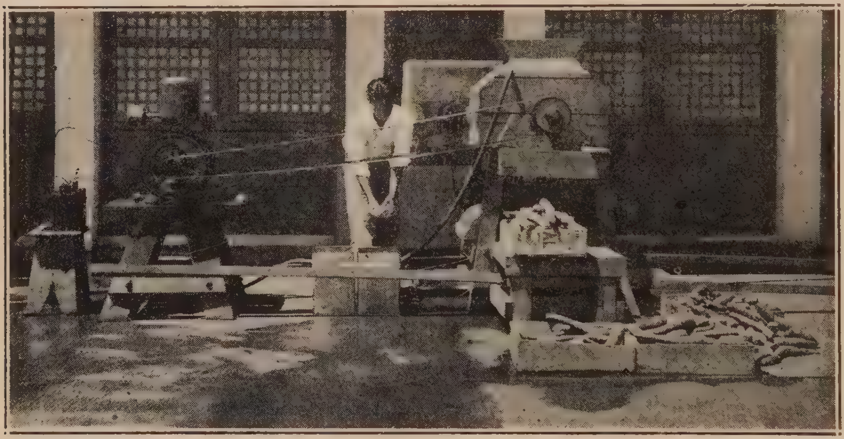
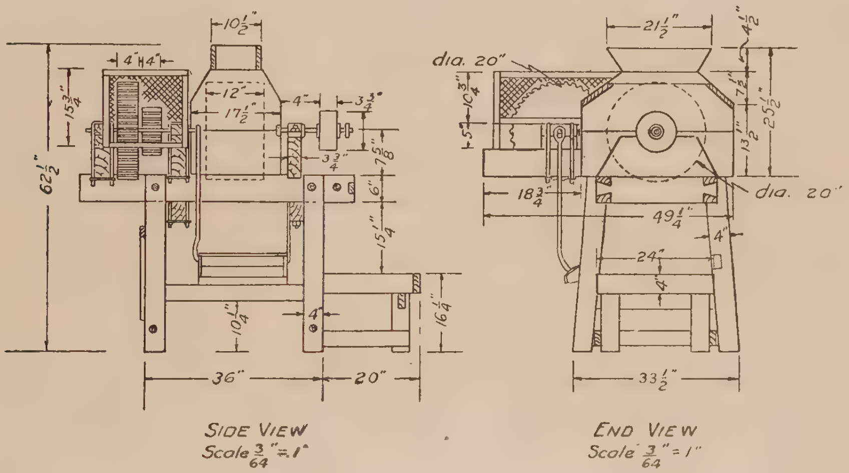


Fig. 11.—The Cuzner cassava machine at the College of Agriculture.

Cost of manufacture and selling price of starch. It is impossible to secure Philippine data about cost of starch manufacture under Philippine conditions. An idea of the cost of manufacture in Java, our greatest provider of starch, may be gleaned from the following information given by Van der Veer (1926), a cassava authority in that country. According to him, in a factory of 5 tons of roots per hour capacity working 100 days a year and 12 hours a day, the cost of manufacture of starch excluding the cost of the roots will be 20.75 guilders per 1,000 kgm. Only items, such as personnel, workers, repair and maintenance, fuel, insurance, taxes, packing and a few others are included in the computation of this cost. Items, such as interest on investment and depreciation are not included. A factory of the capacity given above cost about 200,000 guilders. The extraction efficiency is placed at 18 per cent of the roots.

Assuming a rate of exchange of 82 centavos to one guilder, the cost of manufacture, excluding cost of raw material, given above is ₱17.02 per 1,000 kgm. or ₱0.017 a kgm. The corresponding prices for flake is ₱23.17 per 1,000 kgm. or ₱0.023 per kgm. If cost of production of roots is ₱0.01 a kgm. the cost of 5.6 kgm. of roots needed to produce a kgm. of starch will be ₱0.056 centavos. Since the cost of manufacture of 1 kgm. starch is ₱0.017 then the cost of production of 1 kgm. of starch will be about ₱0.073. In the port of Batavia the wholesale price was recently around ₱0.13 per kgm. Starch imported into the Philippines, except that coming from the United States, pays an import duty of ₱0.04 per kgm.



SIDE VIEW
Scale $\frac{3}{64}$" = 1"

END VIEW
Scale $\frac{3}{64}$" = 1"

Fig. 12.—A plan of the Cuzner cassava machine (prepared by Mr. E. N. Bautista of the Engineering Department).

In the Philippines, *gaogao,* the native name for cassava starch is sold in three market classes, the first class, second class and third class. The first class is pure white, the second, a bit darker while the third is dull brown. At one time these grades were selling at ₱12.00, ₱10.00 and ₱8.00 a picul wholesale, respectively. These prices are equivalent to approximately ₱0.19, ₱0.16 and ₱0.13 respectively, per kgm. At other times the price is somewhat lower than these. The first class cassava starch is retailed at Chinese and other small tiendas at about ₱0.24 a kgm., or in wrapped lots lighter than a kgm., at a somewhat higher price.

To those who have starch to sell, the following list of starch dealers furnished by the Director of Philippine Bureau of Commerce and Industry on October 1, 1931, should be of interest.

Wong Yu & Co.—436 Poblete, Manila.
Kwong Chui Yuen—432 Poblete, Manila.
Owyong Punshek—424 Poblete, Manila.
Nam Shing Cheong—418 Poblete, Manila.
On Yu & Co.—249 Mariquina, Manila.
Kwong Lee Yuen—240 Mariquina, Manila.
Kwong Wha Loong—321 Claveria, Manila.
Dy Buncio & Co.—191 M. de Binondo, Manila.

Price of the waste, or cassava bagasse. In Batavia, Java, the price of this material is about ₱0.04 per kgm. In the Philippines one who has produced it using the Cuzner machine and used it for feed for hogs thought it could be sold for ₱0.07 a kgm. This appears to be quite a high price. The bagasse, however, in this case probably had more starch and other feed constituents than the ordinary by-product of a large factory with more efficient methods of extraction. It may be mentioned here that when the price of starch is high, the dried cassava bagasse which is usually used as live stock feed, wet, is ground, and the finest portion obtained is used to adulterate the low grade starch.

Price of gaplek. Ordinarily this is sold in Java at ₱0.03 to ₱0.04 a kgm.

Price of cassava cuttings. Cuttings of native varieties are sold at the College of Agriculture at ₱0.03-₱0.05 a meter, while foreign varieties sell at ₱0.05-₱0.10 a meter. A discount of 10 per cent is offered for orders for not less than 500 meters. Orders should be placed about a year in advance.

OUTLOOK FOR THE CASSAVA INDUSTRY IN THE PHILIPPINES

According to Annual Reports of the Philippine Bureau of Customs the importation of starch into the Philippines from 1917 to 1929 has been as shown in table 6.

TABLE 6

Amount and value of starch imported into the Philippines from 1917 to 1930

YEAR	QUANTITY	VALUE	YEAR	QUANTITY	VALUE
	kgm.	*pesos*		*kgm.*	*pesos*
1917	1,374,966	199,809	1924	3,073,922	607,460
1918	1,767,956	388,483	1925	2,991,202	540,647
1919	2,000,286	509,398	1926	3,370,477	591,089
1920	2,442,788	567,725	1927	3,569,450	509,007
1921	2,785,645	341,296	1928	4,235,567	508,868
1922	3,209,155	504,540	1929	3,261,105	441,063
1923	2,809,445	578,178	1930[a]	6,249,498	928,559
Ten year average, 1920-1929 inclusive				3,175,376	498,987
Average value per kilogram					15.7 centavos

[a] Data taken from Philippines Farm Journal, 1930, Vol. IV, No. 9, p. 7.

Of the 6,249,498 kgm. imported in 1930, 4,729,925 kgm., mostly corn starch, came from the United States; 1,219,176 kgm., practically all cassava starch, from the Dutch East Indies; 250,579 kgm. from China; 47,212 kgm. from British East Indies; 1,909 kgm. from Japan; 587 kgm. from Germany; and 110 kgm. from Belgium.

As shown in table 6, the average annual importation of starch into the Philippines for the ten year period 1920 to 1929, inclusive, amounted to 3,175,376 kgm. This is equivalent to a daily importation of 8,700 kgm. To produce this amount of starch it would be necessary to mill 15,876,880 kgm. of fresh roots yearly or about 52 tons of fresh roots daily, excluding Sundays and holidays, assuming an extraction efficiency of 20 per cent.

According to the 1918 Philippine Census, the Philippines had in 1918 about 2,225 hectares planted to cassava with a total production of 25,278,923 kgm. Hectarage and production today should be about the same as in 1918. This is equivalent to an average production of only 11,361 kgm. a hectare. With better varieties and methods of culture the country should be able to produce at least 25,000 kgm. per hectare. In other words to produce the nearly 16,000,000 kgm. of roots which would be required in the manufacture of all imported starch, it will be necessary to produce more than 41 thousand tons of roots. If better varieties of cassava are used and proper methods of culture are adopted, it will not be necessary to increase the acreage, as at the rate of production of 25,000 kgm. a hectare 2,225 hectares should produce 54,625,000 kgm. which is more than the amount of cassava roots consumed by the population plus the amount for starch manufacture. Actually, however, the roots needed for the cassava manufacture will not be grown in all the cassava producing provinces (see table 7) since the factories that will undertake the work of starch manufacture will have to draw their raw materials from farms surrounding their mills. Therefore, this will mean that nearly 1,000 additional hectares will have to be devoted to cassava to take care of the production of imported starch.

To produce all the starch consumed in the Philippines according to customs data, there ought to be at least ten factories with an average capacity of 15 tons of fresh roots daily, working about 100 days a year. To obtain 15 tons of fresh roots, assuming a production of 25 tons a hectare, it is necessary to harvest three-fifths of a hectare of cassava each operating day for each of the ten mills. As the cassava is not ready for harvest until about a year after planting, this will mean that every year, each mill should have at least 100 hectares for cassava culture purposes managed fractionally at the rate of 8 or 9 hectares a month.

TABLE 7

Area planted to cassava and production in different cassava producing provinces of the Philippines in 1918 (1918 Philippine Census)

PROVINCE	AREA	PRODUCTION	PROVINCE	AREA	PRODUCTION
	Ha.	*kgm.*		*Ha.*	*kgm.*
Abra	0.25	——	Masbate	189.00	12,359,860.0
Albay	12.00	4,686.0	Mindoro	6.00	8,427.0
Ambos Camarines	8.50	80,500.0	Misamis	0.50	290.0
Antique	2.25	2,770.0	Occ. Negros	9.75	25,283.0
Batangas	10.50	7,918.5	Or. Negros	1.50	220.0
Bohol	39.75	1,708,368.0	Nueva Ecija	0.05	116.0
Bukidnon	44.00	537,249.0	Palawan	24.50	504,120.0
Capiz	26.50	219,939.0	Romblon	0.50	200.0
Cebu	137.50	324,604.0	Samar	36.50	40,820.0
Davao	1.25	516.0	Siquijor	236.50	127,141.0
Iloilo	1.00	1,248.0	Sorsogon	0.75	96.0
Laguna	3.00	37,200.0	Surigao	0.50	418.0
Lanao	6.00	6,361.0	Sulu	1409.00	9,104,682.0
La Union	0.25	400.0	Tarlac	0.05	116.0
Leyte	9.75	48,769.0	Tayabas	4.00	112,740.0
Marinduque	3.25	9,267.0	Zambales	0.25	4,598.0
Total				2,225.10	25,278,922.5
Average per hectare				——	11,361.0

Table 8 shows the amount and value of cassava products imported into the United States from 1919 to 1928, mainly from the Dutch East Indies.[3]

TABLE 8

Amount and value of cassava products imported into the United States from 1919 to 1928

YEAR	QUANTITY	VALUE
	pounds	*dollars. (U. S. currency)*
1919	95,652,647	4,973,938
1920	99,286,119	5,659,309
1921	50,458,450	1,665,129
1922	89,027,246	2,759,845
1923	93,882,460	4,224,711
1924	83,491,156	3,757,102
1925	118,411,974	4,144,419
1926	103,938,420	3,222,091
1926	110,408,412	3,201,844
1928	171,215,709	3,766,746
Average yearly	101,577,259	3,737,323

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[3] Korte Berichten van Landbouw, Nijverheid en Handel—Mart, 7en, 1930.

The Dutch East Indies also exports large quantities of cassava products to England, France, the Netherlands, Singapore, Hongkong and Japan.

The data in table 8 are significant. They show that the United States with which the Philippines has free trade relations is increasing an already heavy importation of cassava products and that it is the heaviest buyer from Java, which exports also to countries and cities which are very near the Philippines. In this connection it is worth mentioning that the Philippine starch manufacturers have one great advantage over those of other countries, except the United States, and that is starch coming from such countries has to pay an import duty of ₱0.04 a kilogram upon entering this country. The price of cassava flour in the United States has been quoted at 3.74 to 6.50 cents (United States currency) per pound during the year 1929.

It should be realized that the consumption of cassava products in this country is capable of a large increase not only because of increase in the use of cassava starch for laundry purposes, but also because of the possible uses of other cassava products and of the starch itself for purposes other than for starching clothes. Cassava starch is known to be better than either potato starch or corn starch for laundry purposes, but it is said to be good also for making pastries, bread, cakes and many other delicacies.

The Philippines has been importing such starch products as flakes, known to the Filipinos as *tapioca*, and pearls, as *sago*[4] for food purposes. The use of these products is capable of popularization. Of course, if the country aims to prevent importation of all cassava products our starch factories will also have to undertake the manufacture of the flakes, pearls and siftings. The United States has been increasing the importation of these products for the last five years. Cassava products have been used in the United States also in textile industries, manufacture of wood glue, manufacture of other glues and pastes and in explosives.

It should also be noted that Europe, the United States and even our neighbor, Japan, have been importing from Java a cassava product, the *gaplek* which is merely dried pieces of peeled cassava roots which can be prepared by our small growers without the need of any expensive appliances. It is up to our trade men to study the foreign markets for this commodity as, with or without starch factories in this county, *gaplek* could be produced and exported.

The cassava industry in the Philippines is in an embryonic stage. Whether or not it will develop will depend on a number of factors. Several attempts made in the past to manufacture starch on a large scale failed, in one case largely because the factory was located very far from Manila so the cost of transportation increased the price of cassava to a prohibitive level. At present the tendency is to have the majority of these factories around Manila. Factories should have the plantations of cassava as close to the mill as possible.

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[4] True *sago* is prepared from the starch of the sagu palm, *Metroxylon sagu* Rothb.

Until the industry is well established it is quite likely that both the planters and the factories will have to be content with little profit. As the tricks of the industry are learned, higher returns may be expected.

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THE RELATIVE EFFICIENCY OF DIFFERENT CHEMICAL AGENTS IN BLEACHING BURI FIBER[1]

F. T. ADRIANO AND J. BANZON
Of the Department of Agricultural Chemistry

WITH ONE GRAPH

The color of many articles of commerce as textiles, feathers, fiber products are improved by a process known as bleaching. Textiles, feathers, straw and other commodities, receive such treatment before marketing. Owing to the widely different nature of these materials, various methods of bleaching have been developed; no one method is of general applicability.

Buri fiber which is extracted from the petioles of buri palm, *Corypha elata* Roxb., is commonly known in the Philippines as *buntal*. From this fiber the well known hats of Baliuag and Lucban are woven. For many years, the buntal hats as well as the raw buri fibers have been exported from the Philippines. From table 1 it may be seen that the export value of these materials is a very considerable item, amounting to ₱6,499,407 in 1928. From that year on the exports kept decreasing. Possibly the quality of fibers of late years is responsible for the decrease in trade.

Buri fiber when freshly extracted is white, but after exposure to the air for some time, it turns brownish. Such fiber brings a much lower price than the white fiber. Consequently, it pays to bleach buri fiber.

Del Mundo (1929) described a permanganate-thiosulfate method for improving the color of buntal fiber. He did not, however, report on the effect on the tensile strength and the breaking stretch of the bleached materials of the permanganate-thiosulfate treatment.

The work here reported was carried out to determine the relative efficiency of the bleaching methods in current use and to find the one most desirable in point of effectiveness, time of treatment, and effect on the strength of the bleached material.

MATERIALS AND METHODS

The fibers used were extracted locally and were allowed to age from two to three weeks. Also fibers that were nine years old were used. These fibers were obtained from the Fiber Division of the Agronomy Department of this College.

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[1] Experiment Station contribution No. 759. Read before the Los Baños Biological Club, August 27, 1931. Received for publication, August 29, 1931.

There are a large number of bleaching agents which are used for the treatment of articles of commerce. It was decided to try them on the buri fiber. These methods were grouped under four classes.

Class I methods, the action of which is due to sulfur dioxide. Class II methods, the action of which is due to chlorine. Class III methods, the action of which is due to oxygen. Class IV methods, the action of which is due to the action of other agents, such as permanganates, acetic acid, oxalic acid, etc.

It was thought that by subjecting the buri fiber to the action of each of the four classes of bleaching agents listed above, the best method would be obtained. Beginning with class I, the following solutions were prepared; 1 per cent sodium bisulfite; 10 per cent sodium bisulfite; 1 per cent sodium thiosulfate; 10 per cent sodium thiosulfate. The buri fibers were cut into convenient lengths, about 10 cm., and placed in test tubes. The prepared solutions previously acidified with 10 per cent H_2SO_4 (5 drops to a full test tube) were poured into each test tube separately. The fibers were examined from time to time and any change in color noted. Some moistened fibers were hung up lengthwise in a large glass tube placed vertically and open at both ends. These fibers were exposed to the action of sulfur dioxide gas generated by burning sulfur at the lower end of the glass tube. The results are given in table 2.

For the second class, the following bleaching solutions were prepared. Chlorine gas was evolved through the action of hydrochloric acid on potassium permanganate; the gas was bubbled through water and then through a 10 per cent solution of sodium hydroxide to saturation. This stock solution was diluted with an equal volume of water and then acidified with 10 per cent H_2SO_4. Some fibers were cut in convenient lengths; placed in test tubes and then treated with the prepared solutions described above. The results are given in table 3.

In class III methods, 1 per cent and 5 per cent solutions of sodium peroxide were prepared, then acidified with 10 per cent sulfuric acid. The solutions were put in test tubes and fibers immersed therein. The results are given in table 4.

With class IV, methods in which various chemicals were used were tried, following the same procedure as with classes I, II and III. The results are given in table 5.

In class IV tests, the following solutions of potassium permanganate were prepared and used as bleacher:

Neutral potassium permanganate	0.5 per cent
Alkaline potassium permanganate	0.5 per cent
Acidic potassium permanganate	0.5 per cent

Alkaline 0.5 per cent potassium permanganate solution was prepared by mixing 5 grams of permanganate, 2 grams of C. P. sodium carbonate and diluting the whole to 1 liter of solution.

Acidic 0.5 per cent potassium permanganate solution was prepared by mixing 5 grams of permanganate, 10 cc. C. P. sulfuric acid and diluting the whole to 1 liter of solution.

The fibers were selected and placed in burettes filled with the solutions given above. The fibers were left in the solutions for thirty minutes. They were then removed and rinsed in water and placed in a decolorizing solution made up of 1 per cent sodium bisulfite solution acidified with 0.4 cc. of 10 per cent H_2SO_4 for every 50 cc. The fibers were left in the decolorizing solution for 5 minutes, then were removed, rinsed in water, dried and examined for color changes. The results are given in table 6.

The next step was to determine the effect of different decolorizing solutions using alkaline 0.5 per cent potassium permanganate solution.

The following decolorizing solutions were tried:

2 per cent thiosulfate acidified with 10 per cent H_2SO_4
2 per cent oxalic acid
1 per cent sodium bisulfite acidified with 10 per cent H_2SO_4 (0.4 cc. per 50 cc.)
10 per cent sodium bisulfite acidified with 10 per cent H_2SO_4 (0.4 cc. per 50 cc.)

The results are given in table 7.

The alkaline permanganate was found to be the most satisfactory so the effect of this method on the tensile strength of the material was determined. The following procedure was used: 130 buri fibers were selected and divided into ten lots, each containing 13 fibers. Five lots were soaked in water (control) and the remaining five were immersed in alkaline permanganate solution (0.5 per cent). After half an hour, one lot was removed from the bleaching bath, rinsed in water and decolorized in 1 per cent sodium bisulfite solution (acidified with 0.4 cc. of 10 per cent H_2SO_4 for every 50 cc.). After 5 minutes the fibers were removed, rinsed in water and hung up to dry. At the same time one lot was taken from the control and treated in the same way. This procedure was repeated after time intervals of 1, 1.5, 2.5 and 5.5 hours. After two days of drying the bleached fibers in air, the breaking stretch and the tensile strength of the fibers were measured by means of the Scott Testing Machine.[2] The results are given in table 8. The data reported represent the average of ten individual determinations.

The tensile strength values are given in terms of kilograms of force per gram of fiber necessary to break one meter of the fiber, that is, tensile strength equals kilograms per meter per gram. In actual determination, the length of the fiber is 25 cm. The tensile strength therefore can be found by the formula:

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[2] Manufactured by Henry L. Scott & Co., Providence, R. I., U. S. A.

$$\text{T. S.} = \frac{\text{Breaking weight in kgm.}}{\text{Weight of fiber in grams}} \times \frac{25}{100}$$

DISCUSSION OF RESULTS

It was thought that by trying the effect of the four classes of bleaching agents on buri fiber, their relative merits would be demonstrated and the best method would be determined.

Table 2 gives the results with class I bleaching agents. The action of these agents depends upon the liberation of sulfur dioxide. It was shown that moist sulfur dioxide gas cannot improve the color of the fiber even after two hours exposure. Sodium bisulfite changed the color of the fiber from brownish to grayish white. It was found that a one per cent solution gave as good results as the ten per cent solution. Acidified sodium thiosulfate solution also made no appreciable improvement in the color of the fibers.

The results given in table 2 and the succeeding tables include only the maximum length of treatment of the fibers with the bleaching agents tested since the shorter time exposure tests gave no noticeable improvement of color.

Table 3 gives the results of bleaching with chlorine evolving compounds. Chlorine water itself was found to actually darken the fiber instead of bleaching it.

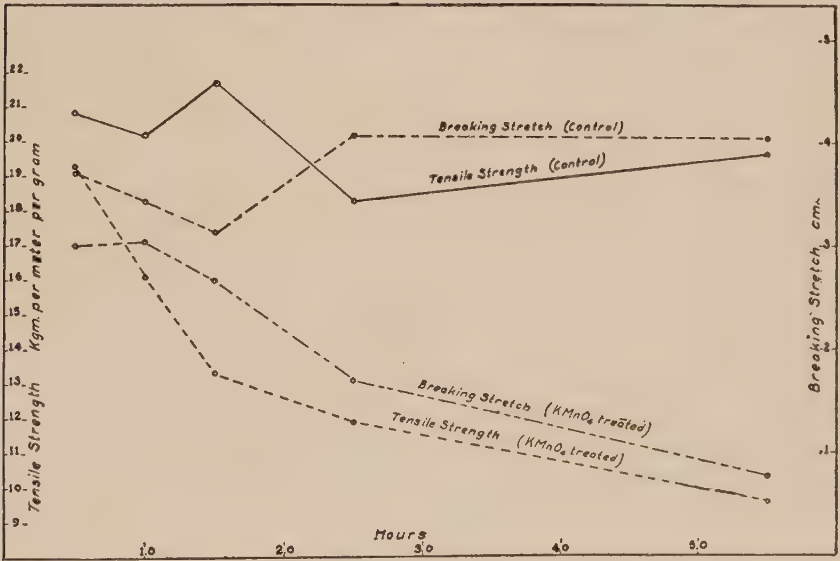
Using an acidified solution of sodium hypochlorite, it was found that the fibers were bleached white but the action is slow and if the solution was acidified sufficiently to hasten the action, the fiber turned brown like the fiber treated with chlorine water. When the sodium hypochlorite solution was boiled the immersed fibers bleached faster, but the fibers were so weakened that they could be pulled apart with little difficulty.

The chlorine evolving compounds as a class were found to bleach well, but the fibers were weakened considerably.

The results of bleaching with the use of peroxide are found in table 4. Sodium peroxide in one per cent concentration was found to be very slow acting. Increasing the concentration to 5 per cent did not improve the bleaching effect.

Table 5 gives the results of bleaching with miscellaneous chemicals. One-half per cent potassium permanganate in alkaline medium produced the most satisfactory results. This chemical requires a "decolorizer" to remove the deposit of manganese hydroxide on the fiber. Acidified sodium thiosulfate or sodium bisulfite solution was found to decolorize well. One-half per cent nitric acid solution produced brownish fibers. Three per cent oxalic acid, even after twenty-four hours contact, gave no appreciable bleaching effect. Formalin even after seventy-two hours, alcohol after two hours and ten per cent acetic acid after two hours contact, were all found to be unsatisfactory bleachers.

Having found potassium permanganate to be the most satisfactory bleacher, the next step was to test which reaction, neutral, acidic or alkaline, would work the best. Table 6 shows that acid potassium permanganate turns the fibers yellowish, while neutral and alkaline permanganate bleach it white. The alkaline treated fiber was glossy, but that treated with the neutral solution was not. Because of these results alkaline potassium permanganate was considered the best bleaching agent.



Graph 1.—Showing the tensile strength and breaking stretch of the permanganate treated and untreated buri fiber.

By increasing the percentage of sodium carbonate above 0.2 per cent no marked improvement was found; the increased alkalinity was found to make the fibers more brittle.

A satisfactory bleacher having been found, the most suitable decolorizer was next sought. Table 7 gives the relative merits of the different decolorizing solutions tried. Oxalic acid which is the chemical pair of potassium permanganate in quantitative reactions was ineffective in removing the manganese hydroxide deposit on the fiber. It produced fibers which were brownish yellow even after long exposure to its decolorizing action.

Two per cent sodium thiosulfate acidified with sulfuric acid decolorized well, but the solution became milky owing to liberation of sulfur. This liberated sulfur deposits on the fiber and thus prevented the decolorizing solution from coming in intimate and uniform contact with the rest of the fibers. This resulted in an uneven decolorization. Sodium bisulfite, one per cent strength, also acidified with sulfuric acid at the rate of 0.5 cc. of 10 per cent H_2SO_4 for every 50 cc. was found to decolorize well and had a further advantage of producing a decolorizing bath free from sulfur deposit.

Increasing the concentration of sodium bisulfite to ten per cent gave the same results as the one per cent solution; the one per cent was selected as the best decolorizing solution.

Finally, the effect of the alkaline potassium permanganate and acidified sodium bisulfite treatment on the tensile strength and breaking stretch of the bleached fibers was determined. Table 8 gives the average tensile strength and breaking stretch measurements of bleached and unbleached fibers after 0.5, 1.0, 1.5, 2.5, and 5.5 hours treatment. The results in table 8 are summarized in graph 1. Each point in the graph represents the mean of ten separate determinations. There is an appreciable decrease in the tensile strength of the fibers as the time of treatment is prolonged. The strength of the fiber treated for half an hour is well within the limits of variation of the untreated fibers so that it may be stated that the bleaching of fibers with potassium permanganate and sodium bisulfite using 0.5 hour contact does not unduly affect the tensile strength of the fiber. Graph 1 also shows the effect of time of treatment on the breaking stretch of the fiber. It may be seen that the breaking stretch of the fiber rapidly decreases as the bleaching treatment is prolonged. The fiber loses its elasticity when brought in contact for a sufficiently long time with the solutions of potassium permanganate and the sodium bisulfite. However, when the treatment is not carried longer than 0.5 hour the breaking stretch of the treated fibers is only slightly if at all affected.

SUMMARY

1. The effect of various bleaching agents on the buri fiber was tried.
2. The sulfur dioxide liberating compounds were found to be unsatisfactory as bleaching agents for buri fiber.
3. The chlorine liberating compounds were not only unsatisfactory as bleaching agents but the bleached fibers were considerably damaged.
4. Sodium peroxide was found to be a very slow acting bleaching agent for buri fiber.
5. Other bleaching agents, such as dilute nitric acid, oxalic acid, acetic acid, formalin and strong ethyl alcohol were found to be unsatisfactory.

6. Potassium permanganate, 0.5 per cent strength, in conjunction with slightly acidified 1.0 per cent sodium bisulfite solution was found to be the most effective bleaching agent for buri fibers.
7. With permanganate bisulfite the treatment for one half hour was found to give a very satisfactory bleach. This length of time affected the tensile strength and breaking stretch very little. Longer treatment, however, weakened the fiber and made it brittle.

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TABLE 1

Showing amount and value of buri fiber and products exported from 1925–1930[a]

HATS

	Buntal		Buri	
year	*number*	*pesos*	*number*	*pesos*
1925	910,132	₱4,669,178	34,779	₱ 6,984
1926	672,260	3,039,160	40,797	8,702
1927	658,984	3,065,621	1,895	829
1928	1,239,629	6,499,407	68,916	47,516
1929	871,844	4,032,123	48,273	20,831
1930	854,578	2,514,682	3,090	2,110

Buntal fibers and basketware[a]

	Buntal fibers		Basketware
year	*kgm.*	*pesos*	*pesos*
1925	28,480	₱ 156,231	₱ 52,329
1926	18,664	91,491	9,504
1927	52,504	257,734	6,972
1928	168,806	913,769	4,493
1929	222,137	1,454,487	1,812
1930	208,567	1,397,269	1,546

[a] From a private communication dated February 28, 1931 from the Director of the Philippine Bureau of Commerce and Industry.

TABLE 2

Results of bleaching buri with class I bleaching agents

BLEACHING AGENTS	TIME IN HOURS	REMARKS
Moist sulfur dioxide gas	2[a]	Very little change in color
1 per cent sodium bisulfite	12	Color changed from brown to gray white
10 per cent sodium bisulfite	12	Color changed from brown to gray white
1 per cent sodium thiosulfate	12	Very little change in color
10 per cent sodium thiosulfate	12	Very little change in color

TABLE 3

Results of bleaching buri fibers with class II bleaching agent

BLEACHING AGENTS	TIME IN HOURS	REMARKS
Chlorine water	12	Fibers turned dark brown
Sodium hypochlorite, cold	12	Color changed to yellowish white very slowly[b]
Sodium hypochlorite, hot	1	Color changed to white rapidly[b]

[a] Owing to difficulty in generating the gas, the test was not carried longer than 2 hours.

[b] Fibers were bleached but they were visibly damaged and could be pulled apart readily.

TABLE 4

Results of bleaching buri fibers with class III, bleaching agents

BLEACHING AGENT	TIME IN HOURS	REMARKS
Sodium peroxide, 1 per cent	12	Little change in color, slow acting
Sodium peroxide, 5 per cent	12	Little change in color, slow acting

TABLE 5

Results of bleaching buri fiber with miscellaneous chemicals (class IV)

BLEACHING AGENT	TIME IN HOURS	REMARKS
Potassium permanganate 0.5 per cent	0.5	Bleached rapidly
Nitric acid 0.5 per cent	2	Fibers turned dark brown
Oxalic acid 3 per cent	24	No improvement
Formalin solution 10 per cent	72	No improvement
Alcohol 95 per cent, hot and cold	20	No improvement
Acetic acid 10 per cent, hot and cold	2	No improvement

TABLE 6

Effect of different reactions of potassium permanganate solution in the bleaching of buri fiber. (Decolorizer, 1 per cent N_aHSO_3*)*

BLEACHING AGENT	TIME IN MINUTES		REMARKS
	Bleacher	Decolorizer	
Neutral permanganate	30	5	Fibers bleached, no gloss
Alkaline permanganate	30	5	Fibers bleached, with gloss
Acid permanganate	30	5	Fibers turned yellowish

TABLE 7

Effect of different decolorizers in the bleaching of buri fibers treated with alkaline (0.5 per cent) potassium permanganate

DECOLORIZER	TIME IN MINUTES		REMARKS
	Bleacher	Decolorizer	
Sodium thiosulfate 2 per cent	30	5	Decolorized well, deposited free sulfur
Oxalic acid 2 per cent	30	5	Fibers remained dark or yellowish
Sodium bisulfite 1 per cent	30	5	Decolorized well, no deposit of sulfur
Sodium bisulfite 10 per cent	30	5	Decolorized well, no deposit of sulfur

TABLE 8

Average breaking stretch and tensile strength of the treated and untreated buri fiber (Potassium permanganate—sodium bisulfite treatment)

LENGHT OF TREATMENT IN HOURS	BREAKING WEIGHT IN KGM.		BREAKING STRETCH IN CM.		WEIGHT OF FIBER IN GRAMS		TENSILE STRENGTH IN KGM., M., GR.	
	Experiment	Control	Experiment	Control	Experiment	Control	Experiment	Control
0.5	2.2951	2.4721	3.07	3.70	0.0295	0.0296	19.4500	20.8792
1.0	1.6584	2.6110	3.13	3.50	0.0234	0.0323	16.1202	20.2090
1.5	1.2219	2.3105	2.67	3.25	0.0228	0.0266	13.3377	21.7972
2.5	1.4345	2.1035	1.73	4.13	0.0293	0.0287	12.2398	18.3232
5.5	0.9525	2.3247	0.92	4.05	0.0244	0.0295	9.7592	19.7008

A REVIEW: "THE FORMATION OF THE HEN'S EGG[1]"

For many, many years the problems connected with the physiology of egg production of birds have attracted the attention of many investigators. Because of its availability, the domestic fowl has been extensively used for the study of these problems. Thus, a great mass of information on the formation of the hen's egg has been obtained. But in spite of all this study there still remains many phases of this problem to be worked out, and many of those already recorded are under discussion.

Doctor V. S. Asmundson, Associate Professor of Poultry Husbandry at the University of British Columbia, Vancouver, Canada, has just published a report of his extensive studies on the normal functioning of the hen's oviduct and factors that may influence same.[2] Some of these studies were made at the University of British Columbia and the others in the departments of Genetics and Poultry Husbandry at the University of Wisconsin. Although the author claims that "the investigation is far from complete", he has uncovered a number of facts hitherto unknown and has confirmed reports of previous studies on many of the phases of the formation of the hen's egg.

In the presentation of the materials obtained in these studies, Doctor Asmundson divided the subject into four parts. Part I deals with the function of the parts of the oviduct;[3] Parts II and III with the determination of the shape and size of the egg.[4] Part IV takes up the formation of abnormal types of eggs, such as (*a*) dwarf eggs, (*b*) multiple-yolked eggs, (*c*) double eggs and (*d*) abnormally shaped eggs.[5] An extensive review of each of these phases of the physiology of egg production among hens accompanies each division.

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[1] General contribution from the College of Agriculture No. 298. Received for publication August 26, 1931.

[2] Asmundson, V. S. 1931. The formation of the hen's egg. Scientific Agriculture (La Revue Agronomique Canadienne) **11**: 590-606; 662-680; 775-788. *Fig. 1-8.*

[3] Asmundson, V. S. 1931. The formation of the hen's egg: I. Function of the parts of the oviduct. Scientific Agriculture (La Revue Agronomique Canadienne) **11**: 590-606. *Fig. 1-3.*

[4] Asmundson, V. S. 1931. The formation of the hen's egg: II. Determination of the shape of the egg: III. Determination of the size of the egg. Scientific Agriculture (La Revue Agronomique Canadienne) **11**: 662-680. *Fig. 4-7.*

[5] Asmundson, V. S. 1931. The formation of the hen's egg: IV. Abnormal types. Scientific Agriculture (La Revue Agronomique Canadienne) **11**: 775-788. *Fig. 8.*

The birds used in these studies included the following breeds: Barred Plymouth Rocks, Rhode Island Reds, Barnevelders, White Leghorns and crossbreeds.

In the studies on the formation of the albumen, shell membranes and the shell, which are generally grouped together as tertiary membranes or sometimes designated the protective and nutritive membranes, fifty-five operations of different kinds had to be performed upon the oviduct of the birds used. From the results obtained, the author concluded as follows:

a. The vagina does not take part in the formation of the hen's egg and that the position of the uterus and its attachment to the ligaments has little or no influence on the muscular activity of the uterus.

b. Half of the isthmus is capable of forming normal shell membranes; the isthmus influences the shape of the egg and this part of the oviduct also influences the pigmentation of the shell.

c. Removal of a part of the oviduct did not cause a reduction of the size of the eggs subsequently laid.

d. Results of earlier work showing that the thin outer albumen, which constitutes over half of the total albumen of the egg, is added after the egg leaves the albumen secreting portion of the oviduct has been confirmed.

e. Conclusions based on earlier work that the yolk increases in weight while traversing the oviduct were supported.

f. It appears that eggs remain in the uterus somewhat longer than the 16 to 17 hours previously estimated.

To study the function of the different parts of the oviduct in the determination of the shape of the egg, various operations were performed on the oviduct such as shortening of the isthmus, narrowing the isthmus, ligation of the isthmus, altering the uterus and freeing the uterus from attached ligaments. Eggs were also removed from the uterus and in one instance, pressure was applied on the uterus. From results of these studies, it is concluded that not only the uterus influences the shape of the egg as was previously reported, but the shape of the egg is also influenced by the isthmus. Apparently, the characteristic shape an egg has is determined when the shell membrane is complete, or sooner.

Regarding his studies on the size, shape and weight of eggs laid, among the conclusions of the author are the following:

a. The relative variability of the weight of the parts of eggs as measured by the coefficient of variation was: shell weight was the most variable and albumen weight the least variable and the weight of egg was relatively less variable than that of any of the parts.

b. Weight of the egg was found to be positively correlated with the weight of each of the parts. Thickness of shell is closely correlated with weight of egg.

c. The correlations between the parts of the egg indicate that the amount of albumen and shell depends to only a limited extent on the size of the yolk.

d. A comparison of bantam eggs with eggs having yolks of the same weight from ordinary hens, showed that the bantam eggs had less albumen and shell. This was interpreted by the author to indicate that the amount of albumen secreted by the oviduct is to some extent dependent on the size of the bird and presumably also on the size of the oviduct.

In the studies on the abnormal types of eggs, the author observed the following:

a. Earlier work from which it was concluded that dwarf eggs generally follow the ovulation of yolks that subsequently escape into the body cavity intact, or after breaking, was supported.

b. Three double-yolked eggs were laid by a hen into whose oviduct an artificial yolk had previously been inserted. Three eggs with elongated stalks were also obtained. One was a dwarf egg that resulted from the insertion of an artificial yolk, and the other two had normal yolks but were laid by a hen that had been operated on twice and artificial yolks inserted, one of which had albumen and membrane secreted around it, while the other was expelled, without any egg envelopes, two days after it was inserted. It was considered that such eggs are due to a displacement of a part of the albumen, caused by constriction in the oviduct or unusual physiologic activity.

The author further stated that there are three processes or series of reactions that must take place, so far as the oviduct is concerned, before a normal egg can be completed. These are (1) the growth and preparation of the oviduct for secretion, (2) the oviduct must secrete and (3) peristalsis or muscular activity must occur so that the yolk, or other mechanical stimulus to secretion, is moved through the lumen of the duct. The last two occur normally together and follow the first, but variations in the functioning of the oviduct indicate that the secretory and muscular activities of the oviduct depend on different physiologic factors.

The extensive list of bibliography of the physiology of egg production appended to Part IV of these studies will be found useful by students and investigators in this important phase of poultry production.

F. M. Fronda
Of the Department of Animal Husbandry

ABSTRACT[1]

How a bean thresher may be made into a rice thresher. JOSE B. BONDOC. (*Thesis presented for graduation, 1929, from the College of Agriculture No. 402; Experiment Station contribution No. 760.*)—The author studied the possibility of using a bean thresher as a rice thresher. He made changes in a bean thresher (that requires 1½ h. p. at full load) to render it efficient for threshing rice. The important change was made in the clearance between the teeth of the concaves, from 7/16 to 5/16 of an inch.

The other modifications were as follows:

1. Front cylinder, from 510 to 641 R. P. M.
2. Rear cylinder, from 648 to 785 R. P. M.
3. Straw rack, from 589 to 390 vibrations per minute.
4. Sieve—the best opening ranged from 3/16 to 1/4 of an inch.
5. Fan, from 13 × 5 to 13 × 3 inches in size. Best results were obtained when the R. P. M. was 445.

The machine when harnessed to a 1½ h. p. International engine threshed from 31.2 to 36 cavans of clean palay in ten hours.

—*Abstract by J. P. Mamisao.*

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[1] Abstract prepared as part of the required work in English *3a*, College of Agriculture.

EXCHANGE NOTES

[About 1830] a Dr. Carlisle, migrating in a sailing ship to Australia from England, took with him, and carefully tended on the long voyage out, a rare plant in a pot. He settled at Scone, some 200 miles north of Sydney, and the doctor's gardener, enamoured of the strange plant, carried it about and established it here and there, expecting it to be a good reserve food for stock in a dry year. Other plants found their way into Queensland further north. They spread rapidly far and wide; the climatic and soil conditions suited the pear; soon it established itself everywhere, beyond control. From then on, the prickly pear (*Cactaceae*) rapidly spread throughout the sparsely-inhabited hinterland of Queensland; it advanced in every direction; it grew with amazing rapidity; it was extraordinarily prolific; there was no stopping it; farmers and graziers were in despair. Forty years later—in 1910—it was estimated that the pear had overrun 20,000,000 acres, and was advancing at the rate of 1,000,000 acres yearly. Over 30,000 square miles of territory had been invaded. By 1916 nearly 23,000,000 acres had succumbed to the pear, or 6,000,000 acres more than the total area under crops in the whole of Australia. . . .

Elaborate machines were constructed for cutting, breaking down, rolling, and destroying the pear. Powerful tractors were brought in and attempts made to drive them through the jungle of growth. Teams of bullocks were harnessed to heavy logs by chains in such a way that the log worked at the side. But all these methods proved inadequate to the tremendous task of destroying the pear over 50,000,000 acres. Mechanical means and human and animal labour having been abandoned, chemical poisoning was next attempted. . . . Finally, it was decided that eradication by mechanical or chemical means would never completely solve this national problem facing the whole continent. . . .

The insects (cochineal) could not even be induced to feed on any kind of prickly-pear except the tree pear, and the pest pear had triumphed once again.

An experimental station was set up, and insects and parasites of all kinds were imported from North and South America. From exhaustive tests there emerged a faint ray of hope in the shape of *Cactoblastis cactorum.* Soon, this stout-hearted little fellow began to be regarded as Australia's "White Hope" in the fight with the pear. . . . Later news on the same subject appeared in a recent message from Sydney, by the British United Press, which states:

"Within three years a million acres of land which had been laid waste by prickly-pear, a cactus plant, have been saved. The plant in the last thirty years has overwhelmed an area of fertile lands in Southern Queensland and Northern New South Wales equal to half the size of England. Scientists were sent round the world to discover a parasite which would kill the plant. But all efforts were unsuccessful until the arrival of the *Cactoblastis* moth. This moth is a prolific layer of eggs, from which emerge grubs that eat into the heart of the plant and kill it. Millions of these moths are now being bred. The summer brood of eggs is ready in February and March, and thousands of consignments will be sent to the stricken districts".

—*The Madras Agricultural Journal,* June, 1931.

The goat is by nature a browser and prefers leaves and twigs to grass, and though looked upon by the man-in-the-street as a scavenger is particular to a degree in choice of food, and when well fed is fond of a change of diet. Again, being a ruminant, a certain proportion of the ration must be made up of bulky food (or roughage). Lack of bulk interferes with the chewing of the cud, and this acts against the laws of nature. It has been noted by stockmen that when this fact has been overlooked by too generous feeding, sickness and in some extreme cases death follows. In drawing up a ration then, provision must be made for bulk, while it is necessary to balance the ration by the addition of concentrates. . . .

The udder of a goat is a most delicate organ, and the goat-keeper must watch and give it every attention from the time the doe begins to spring until she is dried off for her next kidding. Carelessness in milking produces a badly shaped udder, while imperfect milking will result in a decreased quantity of milk. Other things being equal, the more frequent the milkings the higher the yield, but it will be found that two milkings in twenty-four hours are sufficient in most cases. Heavy producers require three milkings. Cleanliness of the udder and milking utensils is necessary to obtain milk that will keep. Clean goat's milk possesses no odour or flavour. . . .

One repeatedly hears the question: "How much milk can a doe be expected to give?" Davies (an authority) mentions that a goat should give in twelve months six times her own weight in milk.

—*The Agricultural Gazette of New South Wales*, August, 1931.

A "five-year plan" for tree planting has been inaugurated by growers in Antelope Valley, California. 50,000 trees will be planted during the next five years.

—*Southern California Crops*, August, 1931.

Farming will never be a success until the farmer has more voice in the disposal of his produce.—P. MORREL.

—*The Madras Agricultural Journal*, July, 1931.

COLLEGE AND ALUMNI NOTES

In September, Prof. Erwin Meyenburg, of the faculty of the University of Berlin, addressed the Student Body on "Germany of the Present Day". Briefly reviewing, not so much the history of Germany as the development of the German mind, Professor Meyenburg then presented a masterly analysis of the Germany of today. It was a scholar's address, free from personal bias. Professor Meyenburg is guest lecturer on German literature and philosophy in the Imperial University in Tokyo.

The inaugural program of The Society for the Advancement of Research was on September 17. Dr. N. B. Mendiola, the president, gave the opening address. The second address was by Dean B. M. Gonzales. President Palma presented greetings, to the new organization. Three associate members, Mr. Jesus de Guzman, Mr. Andres H. Mane and Mr. Roberto H. Tirol were initiated.

The S. A. R. is an Honorary Scientific Society recently organized. On the roll as active members are:

J. Fajardo
F. M. Fronda
A. K. Gomez
B. M. Gonzalez
L. G. Gonzalez
J. B. Juliano
M. Manresa
N. B. Mendiola
G. O. Ocfemia
E. H. Pañganiban
R. L. Pendleton
M. L. Roxas
F. O. Santos
M. D. Sumulong
L. B. Uichanco
D. Villadolid

The officers are:

N. B. Mendiola	*President*
R. L. Pendleton	*Vice-President*
F. M. Fronda	*Secretary*
J. B. Juliano	*Treasurer*

Governor Manuel Fortich, Mr. Rafael Roces and Representative Jose G. Sanvictores were visitors on the College Campus on September 28, 1931. They were especially interested in the poultry work. Also, they inspected the foundation herd looking for a Philippine breed of work-beef cattle. Governor Fortich has done pioneering work in the now very significant cattle industry in Bukidnon and Messrs. Roces and Sanvictores have interests in cattle ranches.

The Philippine Poultry Journal, No. 1, Vol. 1, made its appearance in September. Editor, Dr. F. M. Fronda of this College. The journal is the "Official Organ of the Philippine Poultry Association". Doctor Fronda is to be commended for his initiative and courage in pushing to the front his special line, poultry. All success to the pioneer poultry publication in the Philippines! If the standard of the first number is maintained the journal should succeed on its merits, if Philippine poultrymen are eager to make a "go" of their business.

We acknowledge receipt of the School of Forestry quarterly, *The Makiling Echo*, issued in October, (mimeographed). It contains interesting and valuable articles pertaining to forestry, many items of importance and personal news. The cover, designed to show effect of forests as protection against erosion, carries its lesson effectively.

The Los Baños Biological Club met September 24, 1931, at 7:30 p. m., in the lecture hall of the Department of Agricultural Chemistry of the College of Agriculture, Los Baños, Laguna.

The following papers were read and discussed:

1. "A report on rice inbreeding in the College of Agriculture"—By Mr. Toribio Mercado and Mr. P. Juachon.

2. "Agricultural survey of the Iwahig Penal Colony."—By Prof. I. Elayda.

Loyalty Day, October 10, celebration, from the Students' Parade in morning to the Students' Jamboree in the evening went off with a "bang". The two notable features of the program were Senator Sergio Osmeña as Speaker of the day and the first appearance of the College Band. Dr. Tomas Rigor as speaker for the Veterans brought back the Camp Claudio days with vividness and humor. The Veterans showed no lessening in vigor as they marched in this Parade. To mention one feature of the colorful Parade without mentioning all, would be unfair. "We liked 'em all".

Mr. Pantaleon Dumlao, B. Agr. '31, writes from Nueva Vizcaya Vocational High School, where he is a farm manager that he is also Cadet Instructor. His letter incloses photograph of his snappy company, and program for October 10—a sort of branch Loyalty Day. An invitation to the "Military Ball" in the evening of October 10 was also received. Dr. Felipe Cevallos, B. Agr. '12, (Ph. D., Univ. of Wis.) is Principal of this School and Mr. Andres Pacis, B. Agr. '25, is an instructor.

On July 24, 1931, the 1000-peso studhorse, Hassan, of the College of Agriculture died of uremic poisoning at the age of 14 years.

Post mortem examination revealed that two exostoses had developed under the lumbar vertebrae which presumably pressed the nerves thus causing the complete paralysis of the hindquarters two days before his death. Inasmuch as he was used as a race horse previous to his acquisition by the College, Dr. A. K. Gomez, the autopsist, entertains an opinion that the strenuous work of running over the race course and breeding work led to the development of the extra bone below the lumbar region. It may be added also that this animal had the habit of standing on his hind legs even upon a slight provocation which might have also contributed to the formation of the exostoses.

Hassan was foaled in Lipa, Batangas, in 1917 out of a native mare and by the famous Arabian stallion, Hassan, Governor General Forbes' famous polo horse, which he gave to the Bureau of Agriculture. Since his arrival at the College on March 21, 1924, until December 6, 1930, the end of his breeding career, Hassan rendered 169 breeding services. The heaviest breeding work was made in 1925, when 37 services were recorded. Brood mares from the neighboring barrios and towns near the College have been brought to get the benefits of his good blood and a number of foals are known to have been dropped. From the College stock, Hassan has already one offspring making good on the San Lazaro Race Track in Manila. This colt carries the name Gray Star and during the short period that he has been running, two prizes are credited to him.

ON ANOTHER KIND OF BANANAS, WHICH, ALTHOUGH IT DOES NOT YIELD FOOD FOR THE NATIVES, PROVIDES CLOTHING[1]

FRANCISCO IGNACIO ALZINA, S.J.

The Filipinos[2] call *abacá* another plant, which looks like a kind of banana, because of the resemblance in trunks, leaves, and fruits (except for the lighter green of the leaves, which are smaller than in some banana varieties), but which after all I take to be different. It has many varieties[3], not fewer than in the edible bananas. This plant, which produces a small flower cluster, has this part more like our artichoke and its fruit than that of the banana. Nothing from abacá is good to eat, because rough, insipid, and tough (although it is eaten in times of need). Hence, God did not create this plant, which is so similar to banana, or *saguing*, to furnish them [the Filipinos] food, but to provide them material to make clothes out of. From this plant certain hemp-like fibers are obtained which are used for weaving cloth and blankets in the same manner as linen, hemp, and others from Spain. The method of getting these fibers is as follows:

The trunk of this plant is cut before the fruit is produced. For this reason it is called *abacá* in their language, from the word *aca*, which means something anticipated. After the fruit is produced, the fibers obtained are harder and more easily broken and thus are little adapted for manipulation. After cutting, the sheaths, called *acac*, which form the entire trunk in overlapping layers, as in bananas, are removed. Then, they are bruised by beating with the hands or feet, folding them up in order to soften them and so that the skin may be more easily removed. The process is called *hilo*. Then the sheaths are sorted, separating the outer sheaths (which are more solid) from the inner, which are more fleshy and porous and which are called *titinsan*. This inner part is left because useless. From the rest, which are the trunk coverings, the outer fibers which serve as framework for the whole sheath and which are coarse and full of flesh are also removed, on account of being undesirable, until the white and good fibers, which are called *halos*, appear. These more solid layers are retted in water for one day. The process is called *lavig*, which means to soak so as to facilitate cleaning. The sheaths are removed from the water the following day, this step being called *haon*, and stripping or combing of the fibers is then begun.

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[1] From an unpublished manuscript written in 1668, and entitled *Historia natural del sitio, fertilidad y calidad de las islas é indios de Visayas*. Translated by Leopoldo B. Uichanco from a transcription of the original Spanish which was kindly furnished by Rev. Miguel Selga, S. J., Director of the Philippine Weather Bureau. For a biographical sketch on Father Alzina, see THE PHILIPPINE AGRICULTURIST **20**: 367-369. Received for publication July 22, 1931.

[2] As in the report on coconuts, the author uses the word "indios", for which "Filipinos" or natives has been substituted by the translator.

[3] The author uses the term "especies", which is obviously misapplied.

Stripping is done by taking those sheaths from which all the very spongy, fleshy and soft parts have been removed. These have now reached a width of the palm of a hand, more or less, and are as long as the height of the trunk, which ordinarily reaches about one and one-half *brazas*[5]. They are scraped with either a small knife or a large one, which is called *bolo* (which we will describe later on), pressed gently down against a soft piece of wood. These sheaths are pulled out with the left hand and by this means the fibers are exposed. By repeating the process many times (*quigui*), the fibers become separated, like the hemp; they are white and clean and are called *lanot*. Every sheath is subjected to this treatment, leaving only the innermost ones because they are soft and their fibers are not good.

After cleaning the fibers, they are placed in the sun in order to set them and that they may put on more body and become firmer. Once dried, they are softened by pounding in mortars, or *luzones* [probably *luzong*—Tr.], which are used for pounding rice. They thus become softer and such fibers as may happen to be attached together become separated. Then the fibers are again spread out and placed in the sun. After tying them up at one end into a bundle, the larger fibers, called *lapnisun*, are singled out and laid aside for use in making small ropes, thick clothing, and other articles. A second kind of fibers, which are more delicate, is also set apart and from this kind is made ordinary clothing, called *tinagsa*, which are worn and with which tributes are paid. A third class is made of the other fibers which are lighter and which are almost like hair and from these are woven fine fabrics, called *nipis*, or *magamay*. The manner by which they are made into cloth, how they are warped and woven, which is very different from that in Spain, we will deal with elsewhere when we treat of their arts and practices.

I have encountered twelve different forms or varieties[6], all of abacá, which I consider to be distinct kinds. They have distinctive names, owing to their having different properties. These twelve different forms are of the plants which are planted and cultivated; because there are also wild ones present in great numbers and with very large trunks. (Not all the wild ones are good and yield fibers for making cloth and fabrics, although some are better suited for the finer kinds, which we call *magamayes*, meaning

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[4] The author uses the word "nervios".

[5] *Braza*, a measure of length equivalent to six feet.

[6] The author again uses "especies".

fine cloth, on account of being more flexible, more delicate, and of a somewhat saffron-like color, which is more graceful in these varieties). The forest varieties are usually gathered or, more properly, cut either competitively or coöperatively, selecting the kind that they know and can distinguish; other kinds would be unprofitable. In harvesting the cultivated kinds, it is not necessary to wait for phases of the moon, because they are generally good all the time, and these are the varieties which are planted most. There are some which need to be cut at first quarter, others at last quarter, others at full moon, and still others when there is no moon. They have all these peculiarities, and the natives recognize them, the plants being their fellow indigenes and of their country.

The variety which is in season throughout the year and which is the best one is called *ponoan* or *poonan*. The first name is applied because the plant is like the head and superior to the others, which is what *ponoan* means, in not having a fixed time for planting and harvesting as well as in the good fibers which are white, long and numerous. *Poonan* means to complete quickly and die quickly, for the plant does not stool more than once and hence it is necessary to replant and renovate every year (an attribute of the good, which always lasts only a short time and ends quickly). There is another variety called *inusa*, which means wonderful, on account of the trunk being very long, so long that by cutting only that which contains fibers, the hanks or bundles obtained are more than two *brazas* long.

Among these plants, there are some which are very difficult to strip, and hence only men do the job, because greater force is necessary; others may be worked easily by women, on account of being softer. From all varieties are obtained what the Spaniards commonly call *lanote* and from this the King's share is drawn. It is made into many kinds of ropes and strings which serve as riggings for ships and for other trappings, even cables. When it is new (and they say it is very strong, although it does not last long when kept wet with salt water), this *lanote* is worked with less care on account of being like a ship cargo and the small price it brings. It has a price only when it is for the King's share, and this consists only of two *varas*[7]–*chinanta*[8] as they call it here, which consists of ten *cates*, and each *cate*, twenty ounces. Hence, one *chinanta* contains twelve and one-half pounds, that is, one-half Spanish *arroba*. The abacá or good *lanote* is sold locally for making blankets, or *cumut*, as they call them here. One bundle, which is as much as may be held between the thumb and index finger is sold for one *real*[9] and sometimes for two when there is a great demand and little abacá.

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[7] *Vara*, measure of length equivalent to 2.78 feet.

[8] *Chinanta*, a Philippine unit of weight equivalent to 13¾ lb.

[9] *Real*, Spanish coin equivalent to 12½ cents gold, or ₱0.25 Philippine currency.

From the sheaths and their extremities which are more slender toward the tip, strips or narrow ribbons are split. When these are dried in the sun, they become like cords, which are more or less large, according to their widths, and which are handy for tying objects and binding articles, without having to look for strings in the stores. Everything is taken advantage of, even the most spongy and porous part (which is left out as it contains no fibers), which when dried in the sun becomes sash-like. It is as broad as a hand or broader, and is used for lining baskets. The baskets are made of split bamboos, or *bacacayes*, and with this lining, are used for holding rice which is either paid as tribute or sold. Finally, from those which are called *lapnis*, or *lupis*, and from the coarser abacá, or *lanote*, are made all cord gears for halters, headstalls, girdles, and other trappings wherever there are horses. God has given these people everything ready made, for He sees and recognizes their poverty, indolence, and misery. It would have been impossible for them to buy those things, for from antiquity, as we shall see presently, they had neither known silver with which to mint coins nor had they had any currency; they merely bartered goods.

In concluding this chapter, we will consider with the abacá and with the banana, which we took up previously, two other plants which somewhat resemble them but in part are different. What is more common here is the one called *saguing saguing*, which means like banana, or small banana, because their fruits are similar, and this is a bramble-like plant. When without thorns, the plant and many others like it are termed *balagun* here, and those that are so called (they are more or less thick according to kind, and they entangle trees) produce from the trunk or body, which is as thick as a thumb and very long (without any leaves, except at the top) several little bananas, somewhat smaller than what we called *saba* above. They are of the same form and color and good to eat when ripe. They are arranged not as racemes but merely as spikes, of which the plant produces ten or twelve and in this way they are scattered in large numbers around the trunk far apart from one another. Hence, they appear as if they were hung there by some one and were not true fruits.

The Filipinos[10] call *pandan* that which the Spaniards call piña, on account of its similarity to the pineapple of Spain (although these are bigger). It also resembles the edible pineapples here; but in the case of *pandan* only some little pines which it has without skin inside are eaten. Hence, it is closer to the pineapple of Spain, and its fruit is strong scented, is between yellow and red in color, very sweet and delicious. Some regard it as phlegmy after a fashion, but I do not consider it so. One of its good properties is to facilitate urination and the water which is distilled with an alembic from this fruit is a cure for uraemia. (Had it been slippery, it could not be a cure but a detriment.) I like it somewhat green rather than ripe on account of the flesh being rather tender and not so sweet as to tire one soon. When made into preserves, it is good, odorous, and a delicacy.

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[10] *Indios* in the original.

Although the plant resembles the bananas in fruiting only once and then dying and in producing suckers from the trunks, it is much smaller, the tallest measuring at most one *vara*. The leaves are like the sheaths of thistles and equally as thorny, although less fleshy, and are also akin to the sheaths of abacá. The fruits of this pineapple, when nearly ripe, are cut and soaked, or crushed and washed. Some shoots are taken and also fibers which are more delicate than those of abacá and stronger, like those of agave. The Filipinos twist these fibers and make them into guitar and harp strings (because here guts, like those from Spain, cannot be used on account of high humidity in this country and hence the strings of those instruments are made of silk). These pineapples differ from those of Spain in that in addition to being larger, they produce some leaves at the top which are smaller than those of the parent plant and which form a crown giving it a special gracefulness. When the crowns are cut together with the adhering flesh at the end where they are inserted, they may also be planted. They are so dense, like plumes, that after planting they produce as many shoots as there are leaves; hence from one, ten to twelve or more may be planted at times. They fruit in one year and then die.

THE CODE OF A KING

"Teach me to be obedient to the rules of the game.

"Teach me to distinguish between sentiment and sentimentality, admiring the one and despising the other.

"Teach me neither to proffer nor to receive cheap praise.

"If I am called upon to suffer, let me be like a well-bred beast that goes away to suffer in silence.

"Teach me to win, if I may; if I may not, teach me to be a good loser.

"Teach me neither to cry for the moon nor to cry over spilt milk."
—King George V. Great Britain

—*The Literary Digest*, August 16, 1930.
Reprinted in *The Fortnightly News*, September 16, 1930.

SOILS OF THE BOKAKENG FOREST MANAGEMENT PROJECT, BAGUIO, MOUNTAIN PROVINCE[1]

ROBERT L. PENDLETON AND DIONISIO I. AQUINO[2]
Of the Department of Soils

WITH FIVE TEXT FIGURES

The Bureau of Forestry is endeavoring to establish typical forest management projects in various types of Philippine forests. For pine forest management there has been selected a tract near Baguio, Mountain Province, which had been logged off about 15-20 years ago, and which for the most part is now carrying an excellent growth of young seedling pines. These trees have developed from the seed trees which were allowed to stand at the time of the logging off. Other portions of the tract, particularly along some of the lower slopes and lower valley slopes, have been farmed for a long period by the Igorots, chiefly by the use of land labor for terrace making and subsequent cultivation. In various parts of the area, there are still visible numerous old Igorot earth wall-fences which once surrounded cultivated fields. In some places there are pines of good size, probably 50 or 75 years old, growing on the old walls. In many places in the cultivated area there exist soils which have been badly eroded because of the wash of the fields themselves and concentration of run-off along trails and cattle paths, and because of the destruction of the natural vegetation through excessive pasturing.

This study of the soil of the Bokakeng region was undertaken in an attempt to get as clear an idea as possible of all the conditions that affect the forest in the area, and the means that should be used to obtain on a permanent basis the most effective management and utilization of this forest tract.

The soils field work was only a rough reconnaissance, for there was available only three days in the field, including the time for sampling. The work was done in December, 1930. The laboratory work is such as we have been able to carry out with our very limited facilities in the Soils Department, College of Agriculture.

The tract studied comprises about 1,000 hectares lying to the south southwest of Baguio, beyond Hospital Hill, west from Kennon Road, and south and east from the Sto. Tomas "trail" as far as Kilometer 8. These two roads are the boundaries on the three sides, and the southern boundary is a line roughly northeast from Kilometer 8 on the Sto. Tomas Road to the Kennon Road. This tract constitutes the headwaters of one branch of the Bued River, and the question of management is of significance not only from the standpoint of the conservation of the soil, but also from the point of view of water power development: the conservation of the run-off and the maintenance of a stream flow as uniform as possible.

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[1] Experiment Station contribution No. 761. Received for publication, May 7, 1931.

[2] The senior author did the field work, collected the samples, and took the photographs; the junior author carried out the laboratory determinations of nitrates, pH, moisture and counts of microörganisms.

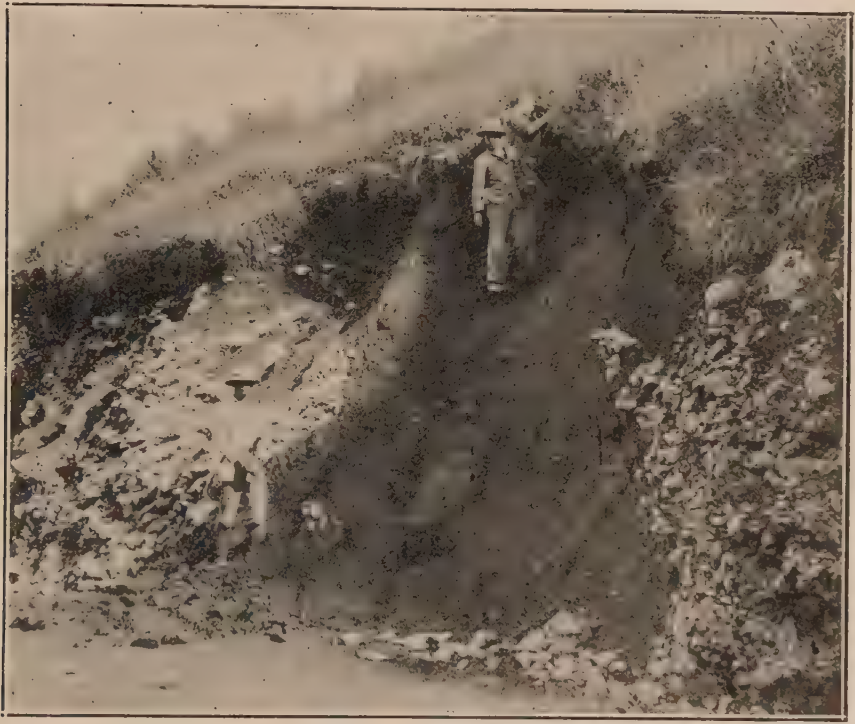

Fig. 1.—Gathering a soil sample of the Mirador series, showing the wide variation in depth of the soil, and the underlying fragmental coralline limestone rock. The exposure is a road cut on the Santo Tomas road.

TOPOGRAPHY

The topography is quite rough. The Sto. Tomas Road follows closely the divide between the Bued River and the drainage to the northwest. From this ridge or edge of the amphitheatre there extends a number of lower ridges out into the area, and between these ridges are the valleys, some steep and forested and some with relatively flat valleys and terraced lower slopes.

As Dickerson (1923), Eveland (1907), Smith and Eddingfield (1911) have pointed out, this region is one of very rapid erosion, the streams cutting down deeply and with strong headward erosion back into the old peneplane of the Baguio plateau. In many cases the slopes are steeper than the angle of repose, and the heavy rains, combined with the deep-seated weathering of the silicates and the solution of the limestones in the underlying strata, are responsible for the landslide conditions which at times are a serious menace to the stability of buildings, as was the case some years ago with the Baguio Hospital just outside the northeastern corner of the area under consideration.

GEOLOGY

Unfortunately a real geological survey of the Philippines has never been made. Most of the geological field work has been of an economic nature, in connection with specific mineral deposits. This was the case with the Baguio region, on which Eveland (1907) published the first comprehensive paper. This paper was followed by the work of Smith and Eddingfield (1911), also of a definite economic nature. The last and by far the most interesting study, of a more general nature, and including a consideration of the physiographic forms, is that of Dickerson (1923).

The main formations that are of economic interest around Baguio are the older rocks in the gold mining region, several kilometers to the east of the area considered in this paper. The Bokakeng Area lies on the coralline limestone of the Malumbang formation (Pliocene) and on the andesitic breccias and tuffs of the Baguio formation (late Pliocene or early Pleistocene). The main portion of the Bokakeng area is made up of the pyroclastics of the Baguio formation, with the limestone appearing in the southwestern portion along the Sto. Tomas road from about Kilometer 5 and running on to about Kilometer 8, beyond which, across a fault, again appear the more recent andesitic volcanic materials.

As a whole, it is very easy to distinguish the region underlaid by the limestones, for it comprises that portion of the area where there are practically no large pine trees, the only ones growing being those recently planted in the course of the afforestation work. Mirador Hill to the north of the area, is characteristic of the limestone region.

Except in the steep cañons of the southeastern portion, there are in the area under consideration few outcrops of solid rock occurring in the portion occupied by the Baguio formation. The probable reason is that the material composing this formation was largely fragmental in nature. On the other hand, the limestone formation as a whole is characterized by a rugged topography, at least on a small scale, with jagged outcrops of limestone and numerous sink-holes, making travelling through the tall grass that covers this formation a dangerous undertaking.

SOILS

The soils of the area as a whole have been much influenced by their geological origin, and by the treatment that they have had from man.

This is clearly shown by the field conditions and also by the laboratory data that are presented in this paper.

The Baguio series of soils, which as a whole are of less rugged topography, deeper and probably much less excessively drained through the subsoil, and which cover most of the area, are the ones that have been most subject to cultivation. The degree of cultivation and pasturage have affected the character of the soils very materially. And, of course, where the terraces have been made, which completely destroyed the original profile arrangement, the original character of the soil has been greatly altered. Because of these changes, this series of soils in this study will be divided into two phases, the dark and the light. The dark phase occurs mainly on the northerly slopes where there is more moisture and where the slopes are steeper, and there has been less human activity on the land, the light phase is less steep on the southern slopes, which are more used for agriculture and are drier. It is probable that at the time of the original lumbering operations there was in the forested portions a great deal of disturbance of the soils, particularly erosion and destruction of organic matter in the virgin soils, but at this date it is impossible to determine the nature and degree of that

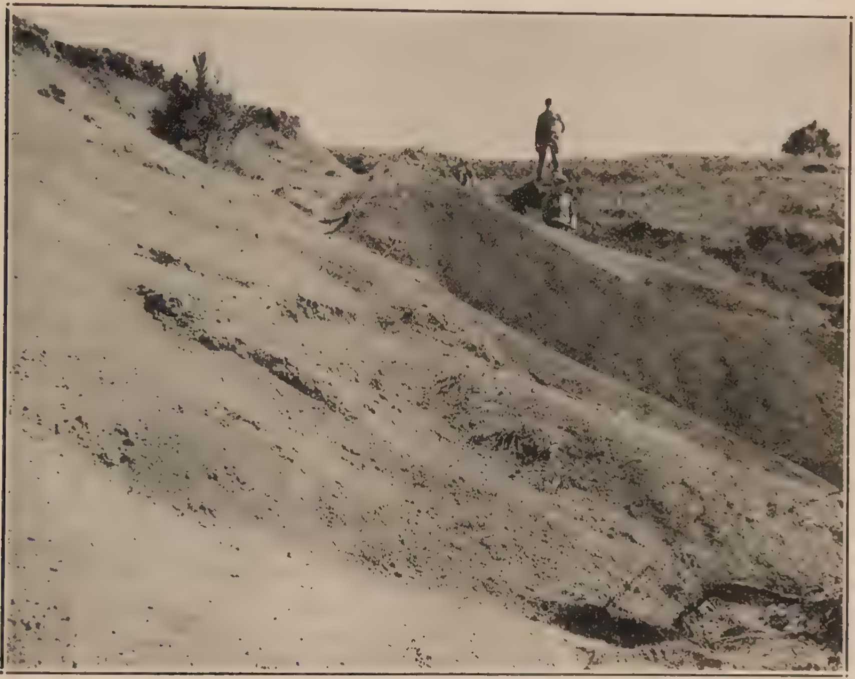

Fig. 2.—Slopes of the Baguio series of soils where serious erosion is following cultivation by Igorots. The deeply weathered soil material crumbles down to a finely granular, loose mass that is easily moved by rainwater. The natural vegetation does not easily cover such deeply eroded slopes.

disturbance. A practice which is playing an important part in the nature of the soils in the area is the raking up and burning of the forest litter. This is done to obtain ashes to sell for fertilizer to the gardeners in Trinidad Valley. Undoubtedly, this practice, which is a considerable industry will in time convert the dark phase soils into the light, or at least assist materially in doing so. As a matter of fact, this practice was observed mainly in the pine forests with the fairly open floor, where the pine needles are one of the important constituents of the litter that is burned. If this be the case generally, the practice is preventing the pine forest soils from again becoming darker, rather than making the dark phase soils lighter. Because of these influences, the Baguio series of soils will be described under two phases, the dark and the light. The dark, presumably, being the original and general, will be considered first and the light phase second, though at the present time the light phase is much more extensive than the dark.

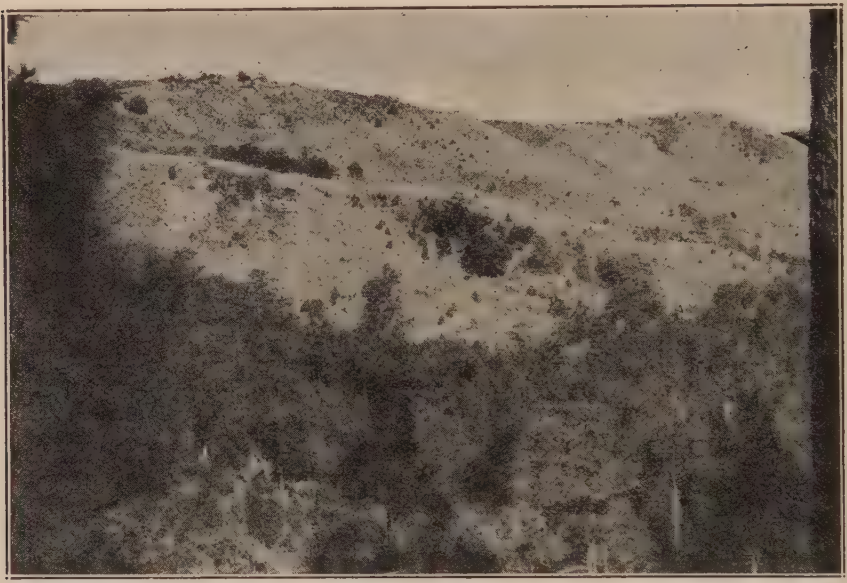

Fig. 3.—A typical occurrence of the Mirador series, in the Bokakeng project showing jagged rocks. Afforestation work has been carried out on this ridge, and the young trees are beginning to be visible. In the foreground and middle distance the dense growth of pine is on soils of the Baguio series.

Baguio series, dark phase. This soil is a loam, with much organic matter, occasionally a silt loam or light clay loam, dark brownish gray to black when moist; 10 to 35 cm. deep. Sometimes it is a stony loam. The subsoil is a light yellowish brown or light brown, varying to a dark brown or brown stony loam, loam, light clay loam, or even a clay. The soil is derived from the andesites and tuffs of the pyroclastics of the Baguio formation. The topography is usually steep. The soil is shaded, or at least little exposed to the sun, and is often on northern slopes. The cover is generally of a much larger proportion of hardwoods than is the case with the lighter phase. This soil is usually located in small patches, often much less than a hectare.

As a whole this soil is found more in the northwest, west, and southern parts of the area, that is, where the steeper slopes are. This type is at times cultivated, and there are on it some terraced cultivated Igorot fields.

Baguio series, light phase. The surface soil when dry is a light brown to brown, grayish brown or most often a reddish brown or even a brownish red; it is a dark brown to brownish red or sometimes, when moist, a dark grayish brown. It is 10 to 15 cm. deep. The texture varies from a loam or a silt loam to a clay loam.

The subsoil is mainly red, with some light brown, or reddish brown or brownish red, not changing appreciably in color between the moist and dry conditions. The depths of the various layers and the succession of horizons is quite variable, depending apparently upon the slope, the nature of the rocks, and the degrees of erosion. The texture varies from a light clay loam to a silt loam or a gravelly loam, but is mainly a clay loam. Excellent sections of this series can be seen all along the Sto. Tomas road as far as Kilometer 5.

Topography is rolling to very steep. The type is covered mainly by pines; about the Igorot villages there is considerable open land; hardwood cover occupies some of the lower shaded slopes. The drainage is excessive. This type is represented by samples 6, 9, 10, 13, 14, 15, 16, 17, 18.

Mirador series. The soils of this series are grayish brown, or dark grayish brown, to black. Where there is considerable organic matter the surface is a light loam to a light or medium clay loam. Where the organic matter is not so great in amount the textures run heavier to a heavy clay loam, and where there are stones, to a stony clay. The surface soil is usually from 10 to 20 cm. deep, but quite variable in depth.

The subsoil is a brown, a light brown or a light yellowish brown, usually not at all reddish in color. Red is associated with the soils from weathered pyroclastics, and not with the soils from limestone. This Mirador series has been derived from the weathering of limestone of the Malumbang formation, which in places is overlaid with fragments of the later Baguio formation, in which case the soil has a redder caste.

The topography is of rounded hill tops to steep slopes, conspicuous because of the open grass cover and the outcrops of jagged limestone. The cover is mostly grass, but a considerable portion in this area is planted to young pines, which are doing well. There seems to be little or no natural reforestation on this soil, though there are some old pine stumps still in place. Professor Curran of the Bureau of Forestry suggests that grass grows well on the limestone soils and burns with intense heat when dry, thus effectively destroying the young pine seedlings, consequently there is little natural reforestation on the soils of this series.

This series is represented by samples 3, 4, 5.

Other soil groups. There are (*a*) the rocky cliffs in the southeastern portion of the area, along the larger streams. (*b*) The made garden soils, which exist in considerable quantity in the southeastern part of the area, along Kennon Road. Being distinctly artificial, and in no sense forest soils, they were not considered further in this study.

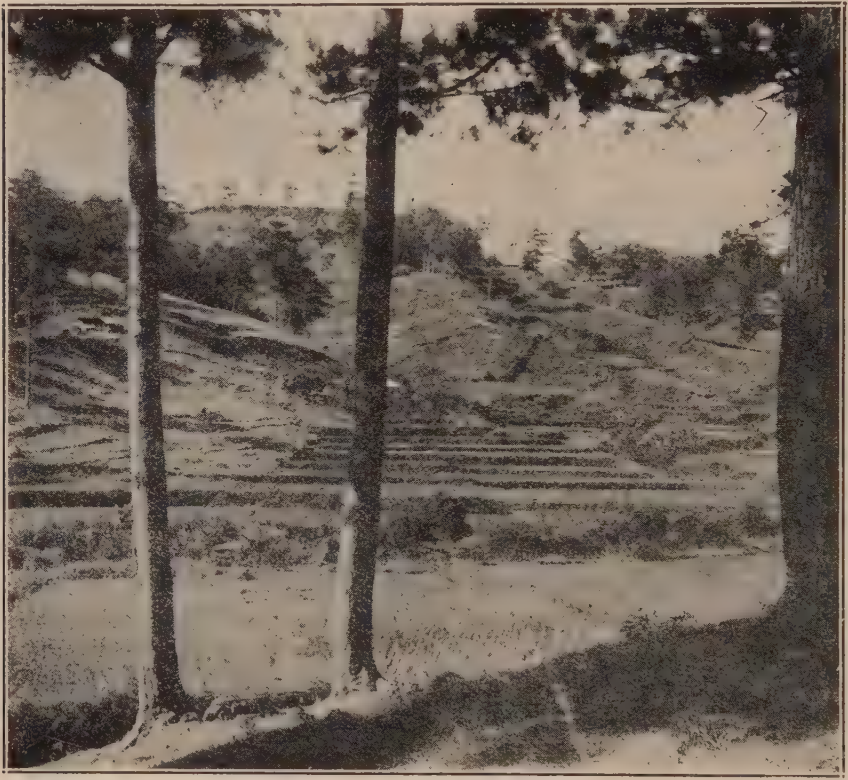

Fig. 4.—Igorot cultivation of the lower slopes and valley bottom in the Bokakeng project. The fields are terraced, 'the house yards planted to shrubs and trees, while the lower slopes are largely deforested and kept bare of all growth, and caused to erode through the over-grazing of cattle.

There is a considerable native population in the Bokakeng area, with two Igorot barrios. The inhabitants are mainly agricultural in occupation, and have an established right to the land. It is clear, however, that certain of their farming practices in spite of the industrious making of terraces and the pasturing of the relatively large number of cattle that they own, are causing serious soil erosion and damage to the forests. As a considerable amount of labor will be needed for the proper development and management of the forest, it is hoped that methods of better conserving the soil may be discovered and put into effect, so that these people may not only be allowed to remain in the forest but will become an asset rather than a danger. The limiting of the number of cattle allowed to pasture in the area will probably be one of the most important ways of reducing soil damage and allowing the extension of the forested area.

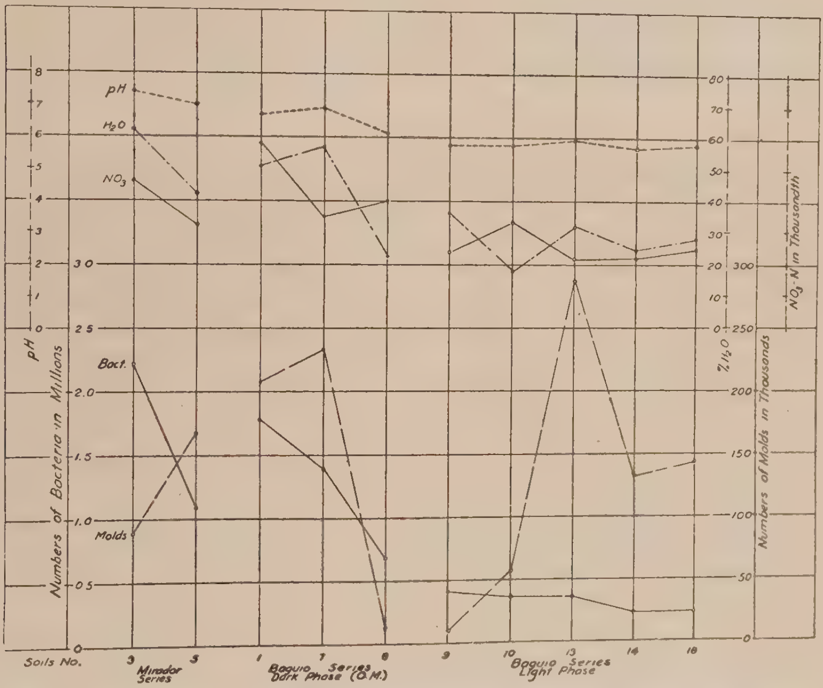

Fig. 5.—Showing the number of bacteria and molds, moisture, reaction and nitrate content of soil.

Mapping of the soils. There was very limited time for work in the field, and there was no suitable map of the region available at the time, hence no attempt was made to locate in detail the series and types of soil described above. The location of the Mirador series was indicated, and the location of the sample stations, but nothing further was possible at the time.

Collection of samples. With as much care as possible the sample sites were selected to represent the various typical conditions and soils. Pits were dug with a shovel, and from the exposed profiles samples were taken. The main samples were placed in canvas sacks, while smaller samples were placed in one pound tight slip-cover tin cans for the determination of the moisture and of the microbiological conditions.

LABORATORY STUDIES

The limited equipment of the Soils Department laboratory has greatly circumscribed the amount of work that we have been able to do on the soil samples. The chemical determinations included the following: Nitrate content, pH by the quinhydrone electrode and by Emerson's colorimetric method. The moisture contents of soils were also determined. In addition there were counts made of the number of bacteria and molds per gram of soil. These data are presented in table 2 and summarized in the graph (fig. 5).

TABLE 2

Number of bacteria, molds, moisture, reaction and nitrate content of soil[a]

SAMPLE NO.	PERCENTAGE MOISTURE	pH	LIME REQUIREMENT, EMERSON'S METHOD	BACTERIA PER GRAM OF AIR-DRY SOIL	MOLDS PER GRAM OF AIR-DRY SOIL	Mg. N AS NO_3 IN 100 GRAMS OF AIR-DRY SOIL
1	50.71	6.68	Very slight acidity	1,768,400	209,000	.058
3–A	62.40	7.36	Neutral	2,241,000	86,210	.046
5–A	41.51	6.96	Almost neutral	1,090,100	166,800	.032
7–A	57.56	6.92	Almost neutral	1,370,000	236,500	.035
7–B	42.43	6.63	Very slight to slight acidity	671,000	10,670	.019
8–A	22.90	6.10	Very slight acidity	638,200	10,640	.040
9–A	23.30	5.76	Medium acidity	400,000	10,600	.036
9–B	30.06	5.74	Medium acidity	266,000	28,000	.016
10–A	33.27	5.72	Medium acidity	358,000	57,310	.018
13–A	21.23	5.97	Very slight acidity	288,700	288,000	.032
14–A	21.93	5.66	Very slight acidity	211,000	131,900	.028
18–A	25.14	5.76	Medium acidity	243,200	143,000	.024

[a] Results given are average of duplicate determinations.

The effects of the parent material are evident in the case of the Mirador series, where the samples are less acid, or are even alkaline. The favorable effect of the reaction is apparent on the microörganisms, and also on the amount of nitrates.

SUMMARY

There is presented a short description of the Bokakeng region, southwest of Baguio, Mountain Province. The region is being studied, particularly from the standpoint of the bearing of the soils on forest management, in connection with the population problems and agriculture that prevail in that region.

The geological formations are briefly described; the older Malumbang limestone and the younger andesitic pyroclastics of the Baguio formation.

Studies of the soils in the field were begun. There are presented descriptions of two series of soils: The Mirador series, and the Baguio series. The Baguio series includes the light and dark phases, which are affected and changed by cultivation and erosion.

The limited time available for the field work and the lack of a suitable map prevented the detailed mapping of the soils.

Attention is called to the important effects of human activity on the soils as they exist at present, and the need for directing the activities of the residents of the area into the proper use and conservation of the soils.

The laboratory determinations show a significant relationship between the parent materials of the soil, the reaction, and the nitrate content, and the numbers of microörganisms.

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TABLE 1

Description of samples of soils of the Bokakeng Project, Baguio

UMBER	DEPTH OF SAMPLES	COLOR		TEXTURE
		Dry	Moist	
	cm.			
1–1 (A)	0–5	Medium brownish gray	Dark gray	Loam, with much organic matter
1–2 (B)	25–85	Light yellowish brown	Yellowish brown	Stony silt loam
2–1 (A)	0–10	Medium and dark gray	Dark gray	Light loam, much organic matter
2–2 (B)	25–60	Light yellowish	Yellowish brown	Loam
3–1 (A)	0–10	Dark gray	Dark gray	Light clay loam
4–1 (A)	0–20	Medium (grayish) brown	Medium grayish	Heavy loam to light clay loam
4–2 (B)	30–60	Light brownish red	Light brownish red	Light clay loam
4–3 (C)	80–120	Light brownish red	Light brownish red	Light silty clay loam
5–1 (A)	0–10	Dark grayish brown	Dark grayish brown	Light silt loam
5–2 (B)	20–40	Light brownish	Light brownish	Clay loam
6–1 (A)	0–10	Brown	Dark brown	Silt loam
6–2 (B)	15–40	Light brownish red	Light brownish red	Light clay loam
7–1 (A)	0–15	Brownish gray	Dark brownish gray	Light loam organic matter
7–2 (B)	20–45	Medium brown	Medium dark brown	Stony loam
7–3 (C)	70–100	Medium brown	Medium dark brown	Loam
8–1 (A)	0–20	Dark grayish brown	Dark grayish brown	Silt loam
8–2 (B)	25–45	Medium brown		Broken stone
9–1 (A)	0–10			
9–2 (B)	20–60	Brownish red	Brownish red	Light silty loam
10–1 (A)	0–30	Medium grayish brown	Dark grayish brown	Loam
11–1 (A)	0–12	Medium brownish gray	Dark brownish gray	Light clay loam
11–2 (B)	15–30	Medium yellowish brown	Medium yellowish brown	Light clay loam
12–1 (A)	0–5	Dark gray	Very dark gray to black	Loam
12–2 (B)	10–20	Medium brown	Medium brown	Light clay loam
12–3 (C)	30–55	Reddish brown	Reddish brown	Stony clay loam
13–1 (A)	0–15	Medium brown	Dark brown	Silt loam
13–2 (B)	25–45	Medium reddish brown	Medium reddish brown	Light silty clay loam
14–1 (A)	0–20	Medium grayish brown	Dark grayish brown	Clay loam
14–2 (B)	25–40	Mottled whitish and yellowish brown	Medium grayish brown	Gravelly clay loam
15) 16)...... 17)		Substratum rock samples from road cut		
18–1 (A)	0–15	Brownish red	Brownish red	Clay loam
18–2 (B)	20–40	Light brownish red	Brownish red	Clay loam

NOTE:—Samples 18–1 and 18–2 were collected at the Forest Station, Baguio, about 2 km. N. E. of the area, and represent a more mature soil, developed on the less eroded Baguio Plateau.

A PRELIMINARY STUDY OF THE LARVAL FISHES FOUND IN THE MOUTH OF THE PANSIPIT RIVER, AND IN BALAYAN, NASUGBU AND BATANGAS BAYS[1]

DEOGRACIAS V. VILLADOLID
Of the Department of Entomology

On the west coast of Batangas Province, Luzon, the fry of bañgos *Chanos chanos* (Forskål) are caught on quite a large scale and sold to fishpond owners to stock their ponds. The purpose of this study was to make a preliminary survey of the larval fishes included in the hauls of fine-meshed nets used in catching this fry. The end in view was to try to find some possible explanation of the reported depletion of the fisheries of Lake Taal and the Pansipit River in Batangas. Persons who are in a position to be familiar with these fisheries where fish for the market are caught are of the opinion that the amount of fish caught at present is markedly less than that of some twenty years ago. Not only is the present catch markedly less, but the fish are, on the average, much smaller than those caught in past years.

There are two types of nets used for catching bañgos fry in Batangas Province. One is finished in the form of scissors net (*salap*), and the other in the form of a small drag seine (*pukot*). Both of these nets are provided with a rather long conical pocket at the middle of the net. The nets are made of sinamay cloth locally woven from abacá fiber.

Hauls made by fishermen engaged in catching bañgos fry were examined. In addition, the writer made personal collections.

RESULTS OF THE COLLECTIONS

In the mouth of the Pansipit River, and along the shore of Balayan Bay lying in the municipalities of Taal and Lemery

During the survey, the writer was able to collect from the mouth of the Pansipit River a large number of young of Carangidae measuring from three to five centimeters in length. The Carangidae is a family of fish to which belongs the maliputo, *Caranx ignobilis* (Forskål); muslo, *Caranx marginatus* Gill; manipis, *Caranx* sp.; and many others which are locally known as talakitok. It is apparent that the larvae of Carangidae enter the mouth of the Pansipit and remain in this portion of the river for some

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[1] Report No. 1 on an investigation trip in April, 1931, for the purpose of studying the fisheries of Lake Taal and the Pansipit River, Batangas Province.

Experiment Station contribution No. 762. Received for publication August 28, 1931.

time or until they reach the length of a few centimeters. Then the young continue to ascend the river until they reach Lake Taal. As to how long the young remain in the river before entering the lake is not as yet definitely known.

Examination of catches made in these localities (mouth of the Pansipit, and the contiguous parts of Balayan Bay) showed the presence of the following:

Larvae of:

1. Dañgat or lañgaray, *Ambassis* spp., Ambassidae. Very abundant. In every haul of the net, there were millions of these larvae.
2. Bañgos, *Chanos chanos*, Chanidae. Quite plentiful. Said to be more abundant during the month of May.
3. Kitang, *Scatophagus argus* (Boddaert), Scatophagidae. Rather few at this time of the year (April).
4. Alamang, Atyidae and Palaemonidae, Crustacea. Exceedingly abundant. Millions were present in every haul of the sinamay net.
5. Alimañgo, katang, alimasag (crabs, Crustacea). Plentiful at this time of the year.

Young and fingerlings of:

1. Aligasin (young banak and talilong, Mugilidae). Very plentiful, mostly fingerlings at this time of the year.
2. Pepikat (young of Carangidae). Rather abundant. Said to be much more abundant during May and June.
3. Sardines (Clupeidae). Not many at this time of the year.
4. Mackerels (Scombridae). Rather rare at this time of the year.
5. Kataba (*Toxotes jaculatrix* (Pallas), Toxotidae). Not many, mostly yearlings taken at this time of the year.
6. Boguin (Hemiramphidae). Not many.
7. Also (Lutianidae). Not many.

In Nasugbu Bay and mouth of Uaua River

Collections made in Nasugbu Bay and in the mouth of the Uaua River showed the presence of the following:

Larvae of:

1. Bañgos (Chanidae). Quite plentiful.
2. Samaral (Siganidae). Present in large numbers in the catch.
3. Lapulapu (Epinephelidae). As in 2.
4. Baracuda (Sphyraenidae). As in 2.
5. Kitang (Scatophagidae). As in 2.
6. Dañgat (Ambassidae). As in 2.
7. Crabs (Crustacea). Present by the millions in every haul made.

Young of:

1. Banak (Mugilidae). Plentiful at this time of the year.
2. Pepikat (Carangidae). As in 1.
3. Sardines (Clupeidae). Not as plentiful as in.
4. Mackerels (Scombridae). As in 3.
5. Samaral (Siganidae). As in 3.
6. Lapulapu (Epinephelidae). Rather common in the catch.
7. Baracuda (Sphyraenidae). Rather common in the catch.
8. Butete (Diodontidae). Not many in the catch.
9. Shrimps (Crustacea). Plentiful in the catch.

In Batangas Bay

In Batangas Bay, the collections yielded the following:

Larvae and fry of:

1. Bañgos (Chanidae). Plentiful in the catch. The bañgos fry were collected even from sloughs and rivers bordering the fish ponds.
2. Lapulapu (Epinephelidae). Both fry and fingerlings were collected. Quite plentiful in the catch.
3. Dañgat or lañgaray (Ambassidae). Both newly hatched larvae and young were collected. Very abundant in the catch.
4. Crabs and shrimps (Crustacea). Mostly newly-hatched larvae. Very numerous in the catch. There were millions in every haul made.
5. Kitang (Scatophagidae). Very few in the catch.
6. Samaral (Siganidae). Very few in the catch.

Young and fingerlings of:

1. Banak (Mugilidae). Rather plentiful.
2. Pepikat (Carangidae). As in 1.
3. Sardines (Clupeidae). Rather abundant.
4. Lapulapu (Epinephelidae). As in 3.
5. Baracuda (Sphyraenidae). Not many.
6. Butete (Diodontidae). As in 5.

A DESTRUCTIVE PRACTICE OF FISHERMEN

The writer observed that it was the practice of the fishermen engaged in the catching of fry of bañgos to throw away on the sandy beach all larvae and young of fishes and crustaceans caught in the nets which were not of the bañgos. By this practice, there is in the mouth of the Pansipit River and along the whole west coast of Batangas Province an unnecessary destruction of larval fishes. Inasmuch as the majority of the larvae destroyed in this manner are those of the transient fishes which periodically enter Lake Taal, great harm is done to the fisheries of Lake Taal and the Pansipit River.

SUMMARY

1. During the summer months, the entire sea coast of Batangas Province, from Nasugbu Bay to Batangas, including the mouths of rivers flowing into them, is rich ground for catching bañgos fry for commercial purposes.

2. Collections made with sinamay nets during April showed the abundance of bañgos fry in the catch. With the fry are caught also in abundance larvae of fishes belonging to the families, Carangidae; Ambassidae; Scatophagidae; Mugilidae; Scombridae; Clupeidae; Siganidae; Epinephelidae; Hemiramphidae; Sphyraenidae; Diodontidae; and many others. Larvae of crabs and shrimps were likewise taken in large quantities in the catch.

3. The present practice of the fishermen of throwing away on the beaches larval fishes and crustaceans, except that of the bañgos, is most

destructive to the coastal fisheries. This harmful practice especially affects the Lake Taal fisheries where the fish of commercial value are mostly transient fishes. Spawning of these transient fishes of Lake Taal takes place in the open sea.

MEASURES SUGGESTED FOR CONSERVING THE FISHERIES OF LAKE TAAL

It is apparent that the unnecessary destruction of larval fishes at the mouth of the Pansipit River and Balayan Bay is an important factor in the depletion of the fisheries of Lake Taal. To stop this destruction it is recommended that the use of very fine-meshed nets (one centimeter or less) be prohibited, especially the use of sinamay nets, in the mouth of the Pansipit River and along Balayan Bay, at least within the boundaries of the municipalities of Taal and Lemery. This regulation would be equivalent to prohibiting the catching of bañgos fry in the regions named. But this measure would have the effect of increasing the runs of larval and young fishes into Lake Taal, thus enlarging the bulk of the fisheries in this region.

It is feared that the authorities of the municipalities of Taal and Lemery will object to this measure on the ground that they will be deprived of the revenues derived from license fees paid by fishermen engaged in the catching of bañgos fry. It should be taken into consideration, however, that increase in the productivity of the fisheries of Lake Taal will more than compensate the loss of the fry licenses. The supply of lumulukso, the maliputo, the muslo, the also (*Lutianus* sp.,) and the boguin (*Hemiramphus quoyi* Cuvier et Valenciennes), which are five of the most important, commercial food fishes of the lake, would certainly be greatly increased.

Likewise, the fishermen themselves will probably object to such a remedial measure on the ground that it would deprive them of the industry of catching bañgos fry. But as bañgos fry can be caught in abundance in Balayan Bay, outside the boundaries of Taal and Lemery, there is no foundation, except that of convenience to fishermen, to this objection. Indeed, the whole coast of Batangas, Balayan, and Nasugbu bays are good fishing grounds for bañgos fry, as was found to be true in the present survey.

The destruction of larval fishes at the mouth of the Pansipit River and its contiguous waters in Balayan Bay is inimical to the development and conservation of the fisheries in Lake Taal. At the source of the river, in the contiguous part of Lake Taal, there takes place also depletion of the same fisheries. Depletion at this point is caused by the almost wholesale capture of mature breeding fish by the *baklad bukana*, a series of fish corrals placed along the shores of Lake Taal bordering the source of the Pansipit, and by the *baklad Pansipit*, a huge, permanent fish corral extending across the river. It is placed at a point about one kilometer from the source of the Pansipit, facing Lake Taal.

Considering that the Pansipit River is the only outlet of Lake Taal, the transient fishes in their periodic movements necessarily pass through it. The presence of the huge *baklad* across the river effectively prevents the fish from reaching their spawning grounds, thus leaving none for breeding stock. This corral is, indeed, a serious menace to an important industry, the fisheries of Lake Taal and the Pansipit River, on which large numbers of people partially or wholly depend for livelihood. Moreover, the economic development of the region is retarded.

Doctor Herre[3] formerly Chief of the Division of Fisheries of the Philippine Bureau of Science called attention to this factor of depletion as early as 1927. But no steps have been taken to improve the condition.

It is clear that in order to do away with this factor of depletion, the *baklad Pansipit* must not be allowed. But the *baklad Pansipit* is built with the consent of the municipalities of Taal and Lemery, which have the legal control of the fisheries of Pansipit River. The power of these municipalities to award to the highest bidder a franchise of the fisheries should be abolished; instead, the right to fish should be available to all inhabitants who pay required license fees, fixed by schedule, for every fishing gear used. It is also recommended that no *baklad* of any kind be erected in any portion of the Pansipit River. *Baklad* may be allowed in Lake Taal and in Balayan Bay.

The foregoing measure will permit a sufficient number of breeding fish to reach their spawning grounds every year.

The writer is aware that it would be a difficult matter to convince the municipal authorities that they should give up their time-honored practice of awarding to the highest bidder the rights to fish in the waters under their control. The practice, however, is established by custom and is not in conformity with modern tenets of democracy, because it is monopolistic in nature. It must be borne in mind that the fish in bays, lakes and rivers is the property of the state and, therefore, the right to fish in these waters belongs to the people as a whole, not to a municipal community.

One point that should be emphasized is that the fishes of Lake Taal are not given a reasonable chance to live, develop, and multiply. They are assailed on all sides; the spawning fish are captured in *baklad Pansipit* and in *baklad bukana* and the larvae of the fish are caught on their lakeward migration by bañgos-fry fishermen who catch them in Balayan Bay and in the mouth of the Pansipit River. Continuous depletion of both the breeding and the larval fish will certainly in time, and not a long period either, bring about the exhaustion of the fisheries. It is not unlikely if the present continuous depletion is not stopped, that in time the fish in Lake Taal will be reduced to a point below the level of commercial abundance.

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[3] Herre, A. W. The fisheries of Lake Taal (Bombon), Luzon, and Lake Naujan, Mindoro. The Philippine Journal of Science, **34:** 287–306.

In the event that the foregoing conservation method is not possible, an alternative remedial measure is proposed. The company holding the franchise to the rights of the fisheries should be made to observe certain regulative measures. The following is recommended:

That the company holding the franchise should provide during March, April, May, and June of each year a runway of at least five meters in width in either wing of the *baklad Pansipit;* this runway to be opened only during the night, say from six in the evening to six the following morning. During the day, from six in the morning to six in the evening, the runway would be closed for the benefit of the company. This measure, it is calculated, would permit a sufficient number of breeding fish to reach their spawning grounds in the open sea to prevent exhaustion of supply of fish.

Some measures of protection must be taken if the fisheries of Lake Taal are to be preserved.

A PRELIMINARY INVESTIGATION TO DETERMINE THE FEASIBILITY OF ESTABLISHING A WATERWORKS SYSTEM IN PINAMALAYAN, MINDORO[1]

ENRIQUE M. BAUTISTA
Of the Department of Agricultural Engineering

WITH TWO TEXT FIGURES

The following report is the result of investigation and surveys made by the writer while he was employed in the Bureau of Public Works to determine the feasibility of constructing a waterworks system in the municipality of Pinamalayan, province of Mindoro. The investigation was made from December, 1929 to April, 1930.

The investigation was conducted to cover the following points: (*a*) quantity of water required; (*b*) condition of present water supply; (*c*) availability of a source of new supply; (*d*) quantity of water from proposed supply; (*e*) minimum discharge of water from proposed supply; (*f*) kind of system proposed; (*g*) location of suitable intake; (*h*) location of reservoir site; (*i*) location of main pipe line; (*j*) total head of water available at intake and at reservoir site; (*k*) distributing system; and (*l*) financial condition of municipality.

APPARATUS USED

A rectangular contracted weir was constructed at the intake sit where the quantity of discharge was determined. Planed boards were used. The length of the weir crest was 1.22 meters (four feet) and the height above the bottom of stream channel was 0.534 meter (1.75 feet). Mortar (mixture of cement and sand in a proportion of 1:3) was used as filler and plaster to make the sides and bottom water-tight.

A transit of the Keuffel and Esser make was used to survey for the locations of the intake and reservoir sites and the main pipe line. The distances were measured with a metric tape. Ten laborers helped make the survey.

A Wye-level of the same make as the transit, and a level rod were used to determine the profile of the main pipe line, and the difference in elevation between the town level, reservoir, and intake sites. Five laborers were employed for the level party.

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[1] Experiment Station contribution No. 763. Received for publication, September 12, 1931.

THE WATER CONSUMPTION AND SUPPLY

The quantity of water required was based upon the number of people in the locality with allowance for increase in population within the next fifteen years. It was found by a house to house canvass that about 2,000 people were living in the town. It was computed that the probable population, in 1945, fifteen years later, would be about 3,000.

Using 76 liters (20 gallons) per capita per day as the basis, the total daily consumption in 1945 would be 228,000 liters (60,000 gallons).

At the time of the survey there was only one artesian well; this was located in the center of the *poblacion*. The water from this well and from eight shallow wells was salty. The only fresh water fit for drinking was secured from three deep wells located about a mile from the town. About 76,000 liters (2,000 gallons) of water were taken from these wells every day. Using bull carts and carromatas for transportation, this water in five-gallon petroleum cans was distributed throughout the town at a charge of 5 centavos per can.

Careful investigation by the writer over a period of about five months showed that the only available source of water supply was from a stream located about six kilometers from the town. The water comes from a mountain spring and flows through virgin forest. Samples of water were collected in two sterilized bottles and sent to the Bureau of Science for biological and chemical analyses. The report showed that the water was chemically pure for drinking and the report through biological examination was also favorable.

The minimum flow of the stream was determined during the driest season of the year, March, April and May.

From table 1 it may be seen that the computed minimum supply per 24 hour-day was 781,677 liters (206,496 gallons). This amount gives about 257 liters (68 gallons) per capita a day. The stream, therefore, is capable of supplying three times as much water as the maximum per capita requirement.

The ideal intake site was located about 6.5 kilometers from the town. It is considered free from pollution since there is no existing habitation above it.

SYSTEM OF WATERWORKS

There are at least three types of systems that are commonly used in waterworks operation—the gravity, the pumping, and the artesian wells. This report deals primarily with the gravity system as the basis for conveyance of water.

Main pipe line

The survey for the location of the main pipe line was made from the proposed intake site to the town. Several trial lines were made to determine the most suitable one with respect to economy and safety of location. As shown in figure 1, there are two proposed lines. The line close to the sea is long and will probably be subject to effects of high water. The other line is short and may be considered safe from tidal effects. This line was selected and its profile was determined.

The elevation of the intake above the town level was determined from the profile and was found to be about 98 meters (321.44 ft.). The materials along the path of the pipe line are rocks and ordinary earth.

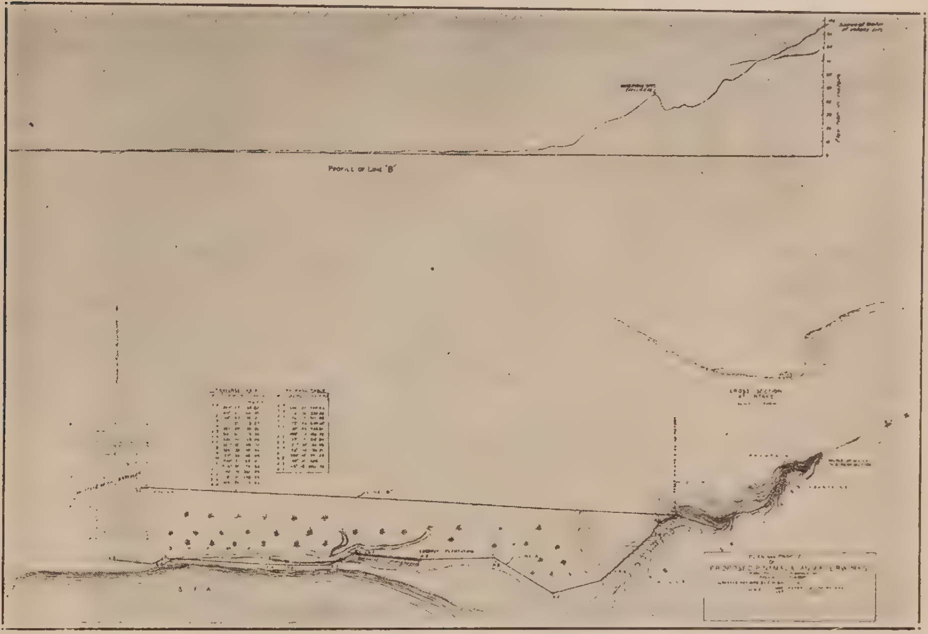

Fig. 1.—Showing the plan and profile of main pipe line, the location of reservoir and intake sites, and the town.

The diameter of the cast iron pipe to be used was computed to be 4 inches. The computation was based on 228,000 liters (60,000 gallons) per day with provision for losses and for a pressure of about 3.515 kgm. per sq. cm. (50 pounds per square inch) at the discharge end of main pipe line. This pressure gives allowance for the water to be raised to a building about 35.1 meters (115.2 feet) high.

Reservoir

Figure 1 shows the location of the reservoir site. A section which is nearly level was selected at an elevation high enough to supply water to the tallest building. The site is about 45 meters (147.6 feet) above the town.

The estimated cost of excavating the reservoir is ₱0.60 per cubic meter. Concrete in place costs ₱50 per cubic meter.

Distributing system

Figure 1 shows the plan of the town. At the time of the investigation there were about 200 houses to be supplied with water. The number of people in a house ranged from 6 to 10. A few people from outlying barrios may come to get water from the system.

Financing of the system

The yearly charges to be met when this waterworks system is in operation are included under the following items: (*a*) Yearly payment on bonds sold to pay for construction; (*b*) annual operating and maintenance expenses; (*c*) payment allotted to a depreciation fund to provide for the renewal of various parts; and (*d*) profit.

The sources of revenue are the water rates and the funds received from general taxation.

In 1928 the total amount of assessed property in the municipality were ₱2,084,020. The total revenue was ₱11,944.33 and the total expenses was ₱10,827.01. These figures show a net income of ₱1,117.32. The municipality had no debts at the time of investigation.

The revenue to be furnished by the system is estimated to be ₱2,500 per annum and the annual operation costs, ₱500.

The total cost of construction as shown in table 2 is estimated from average cost of labor and the current prices of materials in the community.

Computations for flow of water through pipes

The force of gravity causes the flow of water from reservoir through pipes. When a pipe carries water under pressure the difference in elevation H (fig. 2) between the surfaces of the water at the intake and outlet is the effective head through which the water is acted upon by the force of gravity. H is the total lost head. This is composed of several individual head losses. In order to convey water through the pipe, there must be some velocity. To produce this velocity a certain amount of head must be used.

Velocity head $h_v=\frac{V^2}{2g}$, (fig. 2) is the head that will be lost to produce velocity V. This loss occurs at intake.

Another head loss is the one occurring at the entrance from the intake into the pipe because of the contraction and eddy currents. It is called loss at entrance and most authorities express it in the formula $h_e=\frac{0.5V^2}{2g}$ (see fig. 2).

The friction loss $h_f=\frac{fLV^2}{d2g}$, (see fig. 2) is caused by the friction of the water against the inner surface of the pipe.

For very long pipes h_f is almost the whole lost head, and h_v and h_e are disregarded in the computations.

Let us consider the flow of water from the reservoir to the town a distance (L) of almost six kilometers (19,680 ft.). The difference in elevation between the reservoir site and the town level is 45 meters (147.6 ft.).

Since the recommended capacity of the reservoir is 228,000 liters (60,000 gallons) or almost 226 cubic meters (8,000 cubic feet) a reservoir 1.22 meters (4 feet) high having an area of 186 square meters (2,000 square feet) will satisfy this condition. The total elevation of the surface of the water at the reservoir above the town will be 45 meters plus 1.22 meters (which is the height of the water in the reservoir) or 46.22 meters (151.6 ft.).

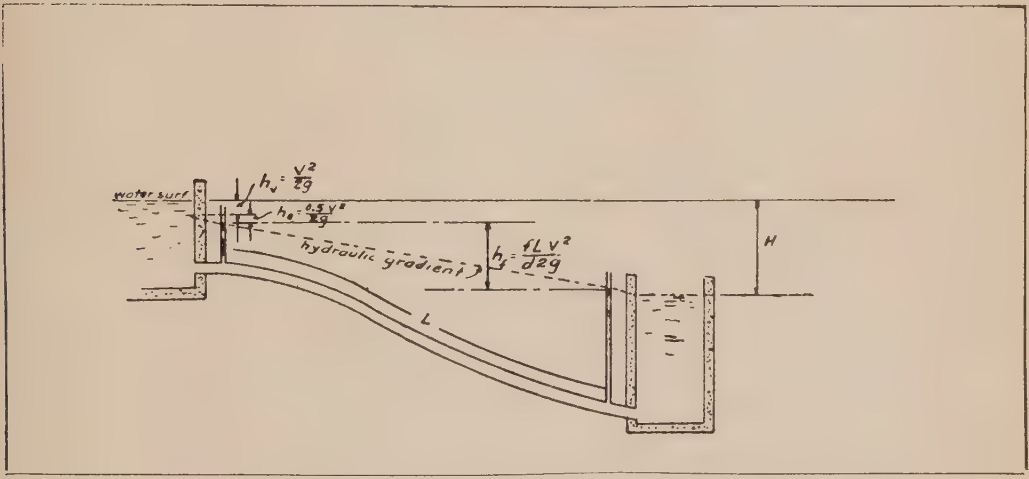

Fig. 2.—Showing the head losses in the flow of water through pipes.

Allowing a pressure of 50-lb. per square inch in the main pipe line, the water will rise to a height of $h_p = \frac{p}{w} = \frac{50 \times 144}{62.5 \times 3.28} = 35.1$ meters (115.2 feet) at the town level.

The difference in height between the surface of the water at the reservoir and the surface of the water at a gauge near the end of main pipe line in the town will be 11.12 meters (46.22 meters–35.1 meters = 11.12 meters, or 36.4 feet).

From the above figures the following values are computed:[2]

$$h_f = 36.4 \text{ ft.}$$

$$h_f = \frac{fLV^2}{d2g}$$

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[2] In this computation, the English units are used to conform with the formula.

where f = friction factor.
L = length of pipe in feet.
d = diameter of pipe in feet.
g = 32.2 ft./sec.^{2}

but $V = \frac{Q}{a}$

where Q = discharge in cubic feet per second.

$$= \frac{60{,}000}{7.48\times24\times3600} = 0.09275.$$

$$\text{or } V = \frac{0.093}{\frac{\pi d^2}{4}} = \frac{4\times0.093}{\pi d^2} = \frac{0.1185}{d^2}$$

substituting $\frac{0.1185}{d^2}$ for V

and 19,680 (6,000 meters) for L

in equation $h_f = \frac{fLV^2}{d2g}$

we have $h_f = \frac{f\times19{,}680\times0.1185}{d^3\times64.4}$

(f) is dependent upon velocity of water, diameter of pipe, and type of conduit; therefore f must be tentatively taken because V and d are both unknown.

(f) may be safely assumed as 0.02 which is the average value.

Substituting 0.02 for f and 36.6 ft. for h_f

$$36.4 = \frac{0.02\times19{,}680\times0.1185}{d^3\times64.4}.$$

$$d^3 = \frac{0.02\times19{,}680\times0.1185}{64.4\times36.4} = 0.0199.$$

$$d = \sqrt[3]{0.0199}.$$

$$= 0.271 \text{ foot.}$$

$$= 3\tfrac{1}{4} \text{ inches.}$$

$$\text{Therefore } V = \frac{0.1185}{d^2} = \frac{0.1185}{(0.271)^2} = \frac{0.1185}{0.0735} = 1.61 \text{ ft./sec.}$$

From Fannings table (Russell, 1909)[3] "f" for a diameter of 3¼ inches and a velocity of 1.61 feet per second for cast iron pipes equals 0.028.

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[3] Russell, George E. 1909. Textbook on hydraulics. 2nd ed., vii+215 p., 129 fig. New York: Henry Holt and Co.

Re-substituting 0.028 for (f)

$$d^3 = \frac{0.028 \times 19{,}680 \times 0.1185}{64.4 \times 36.4} = 0.0278.$$

$$d = \sqrt[3]{0.0278} = 0.3 \text{ foot.}$$

$$= 3.6 \text{ inches.}$$

Since the diameter of the pipe on the market closest to 3.6 in. is 4 inches the value for d may be taken as 4 inches. With this value of d, the velocity will decrease, while the pressure head will increase and quantity of discharge be the same as before.

Russell (1909) following the work of Williams and Hazen recommended the following formula for velocity,

$$V = C'R^{0.63} \quad S^{0.54}$$

where C' = coefficient of retardation.

For cast iron pipes Daugherty (1919)[4] recommends 170 as a conservative value for C' to be used in design using this formula,

R = hydraulic radius.

$= \frac{d}{4}$ for circular conduit water flowing full.

S = slope of hydraulic gradient.

In the present problem

$$S = \frac{36.4}{19{,}680} = 0.00185.$$

From the present problem

$$V = \frac{Q}{A} = \frac{0.1185}{d^2}$$

Substituting the value of V in the above formula

$$\frac{0.1185}{d^2} = 170 \left(\frac{d}{4}\right)^{0.63}(0.00185)^{0.54}$$

By cut and try method the value of d is assumed as 0.3 foot.
Substituting this value of d,

$$\frac{0.1185}{(0.3)^2} = (170) \left(\frac{0.3}{4}\right)^{0.63}(0.00185)^{0.54}$$

$$1.318 = 170(0.1956)\ (0.03344)$$

$$1.318 = 1.11.$$

By another trial value of d, the left and the right side of the equation can be made equal or approximately equal. From the previous result using a trial value of 0.3 ft. for d it can be seen that the variation is very slight. So another trial value of d, will not vary much from 0.3 foot or 3.6 inches.

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[4] Daugherty, R. L. 1919. Hydraulics. 2nd ed., xv+267 p., 245 fig. New York: McGraw-Hill Book Co., Inc.

Using the Chezy's formula (see Russell, 1909) for open channels and through pipes as

$$V = C\ R^{0.5}\ S^{0.5}$$

we have

$$\frac{0.1185}{d^2} = 130\left(\frac{d}{4}\right)^{0.5}(0.00185)^{0.5}$$

C for cast iron pipes in this formula is recommended by Daugherty (1919) for design as 130.

By cut and try method with an assumed value of d as 0.3 foot,

$$\frac{0.1185}{0.3^2} = 130\left(\frac{0.3}{4}\right)^{0.5}(0.00185)^{0.5}$$

$$1.318 = 1.53.$$

In this result 0.3 foot is slightly larger than what it should have been to balance the equation.

These three results show that the variation of d is very slight, using the three formulas given.

SUMMARY

1. The estimated quantity of water supply required is 228,000 liters a day.

2. The present water supply is not fit for drinking or for domestic purposes.

3. The only possible source of supply is from a stream, the water from which upon due examination by the Bureau of Science was found to be chemically and biologically good for drinking and domestic purposes.

4. The stream has a minimum discharge of 9.05 liters (2.39 gallons per second, or 206,496 gallons per 24-hour day).

5. The location of plans of intake and reservoir sites and main pipe line are recommended as the most feasible ones.

6. A total head of about 98 meters was obtained at intake site and 45 meters at reservoir site.

9. A diameter of 4 inches cast iron pipe will give a discharge of 0.09275 cubic foot per second or 228,000 liters (60,000 gallons) per 24-hour day. It will also allow a pressure of about 3.515 kgm. per sq. cm. (50-lb. per square inch) sufficient to raise the water to a height of 35.1 meters (115.2 ft.) above the town level.

8. The municipality had a net income in 1928 of ₱1,117.32 with no debts. The revenue to be furnished by the proposed waterworks system is estimated at ₱2,500 per annum, with a yearly operation cost of ₱500. The total cost of the system is estimated to be about ₱50,000 at ₱7.66 per lineal meter of pipe.

TABLE 1

Showing observed heads for minimum flow of Babahurin stream: Francis rectangular contracted weir

$L = 4$ feet

DATE OF OBSERVATION	(H) OBSERVED HEAD
1930	*inches*
April 4	1.00
April 5	1.10
April 6	1.20
April 7	1.00
April 8	0.90
April 9	0.80
April 10	1.00
April 11	1.00
April 12	1.00
April 13	1.00
Average head = 1 inch or 0.083 ft.	

Formula used for determining discharge

$$Q = 3.33\left(L - \frac{2H}{10}\right) H^{3/2}$$

where:

Q = cubic feet per second.
H = observed head.
L = length of weir.

Therefore $Q = 3.33[(4 - \frac{2}{10}(0.083)](0.083)^{3/2}$

$= 0.3196$ cubic foot per second.

Since 7.48 gal. = 1 cubic foot.

Therefore $Q = 0.3196 \times 7.48 = 2.39$ gallons per second.

$= 9.05$ liters per second.

TABLE 2

Estimated cost of waterworks

ITEMS	UNIT COST PER LINEAL M. OF PIPE	TOTAL COST
	pesos	*pesos*
Excavation and backfill for a trench 50 cm. wide and 80 cm. deep	0.20	1,300.00
G. I. pipes and fittings 4″ diameter, 6,500 meters long	3.50	22,750.00
Lead and yarn	0.10	650.00
Valves and boxes	0.10	650.00
Reservoir (60,000 gal. capacity) at ₱100 per 1,000 gallons	——	6,000.00
Intake	——	2,000.00
Tools and labor	1.00	6,500.00
Contracting and engineering	0.40	2,600.00
Contingencies	0.15	975.00
Transportation	0.38	2,470.00
Provincial surcharge at 5%	——	2,294.75
Insular surcharge at 3%	——	1,565.70
Total		49,755.45

POKKAH-BOENG, A DISEASE OF SUGAR CANE FOUND ON A JAVA CANE VARIETY IN THE PHILIPPINE ISLANDS[1]

E. F. ROLDAN
Of the Department of Plant Pathology

WITH TWO TEXT FIGURES

The occurrence of the Java cane disease, Pokkah-Boeng, in the Philippine Islands was first noted by the writer in January, 1930 in the sugar cane breeding garden of the College of Agriculture at Los Baños, Laguna. It has not been described before in this country. The disease was found to occur on Java cane variety P. O. J. 2878. On a recent trip to Del Carmen, Pampanga, the writer found again positive cases on the same Java cane variety P. O. J. 2878. On this particular variety the disease seems to be prevalent in Pampanga, and there seems to be grave danger of the disease gaining a foothold and becoming a destructive cane disease in the cane areas of the Islands if proper and systematic precautionary methods are not undertaken to check it.

It is the object of this paper to make a brief report on Pokkah-boeng.

The disease may be described as follows:

Under field conditions the appearance of the disease varies according to the severity of infection. Distortion of various types, such as tangling, twisting, and bunching of leaves accompanied by partial chlorosis at the base of the younger leaves is the most reliable symptom (fig. 2 b). In the early stages of infection irregular yellow chlorotic areas at the base of the leaves are present and unless the disease is outgrown, this condition causes stunting, corrugation and complex matting of the leaves. As the disease advances in cases of severe infection, the entire cane top may ultimately rot. Ladder-shaped cavities are frequently found in the stem immediately below the spindle and constitute another reliable symptom, especially in severe cases of the disease. The cavities may be confined to a single internode or they may extend to several nodes and internodes (fig. 1 a and b). A long line of depression originating in the main cavity may in some cases be found, the length of this varying according to the severity of the disease. The cavities may or may not be found in the stem, but in severe cases they are invariably present, penetrating deeply into the tissues of the stalk. When

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[1] Experiment Station contribution No. 764.

Read before the Los Baños Biological Club, October 30, 1930. Prepared in the Department of Plant Pathology under the direction of Dr. F. L. Stevens, Charles Fuller Baker Memorial Professor of Plant Pathology, College of Agriculture. Received for publication November 21, 1930.

the stem is opened, the ladder-shaped cavity becomes very evident. Reddish brown streaks in the affected area are common and are always found along the vascular tissues. When sections are made and examined under the microscope fungous threads are found penetrating the vascular cells.

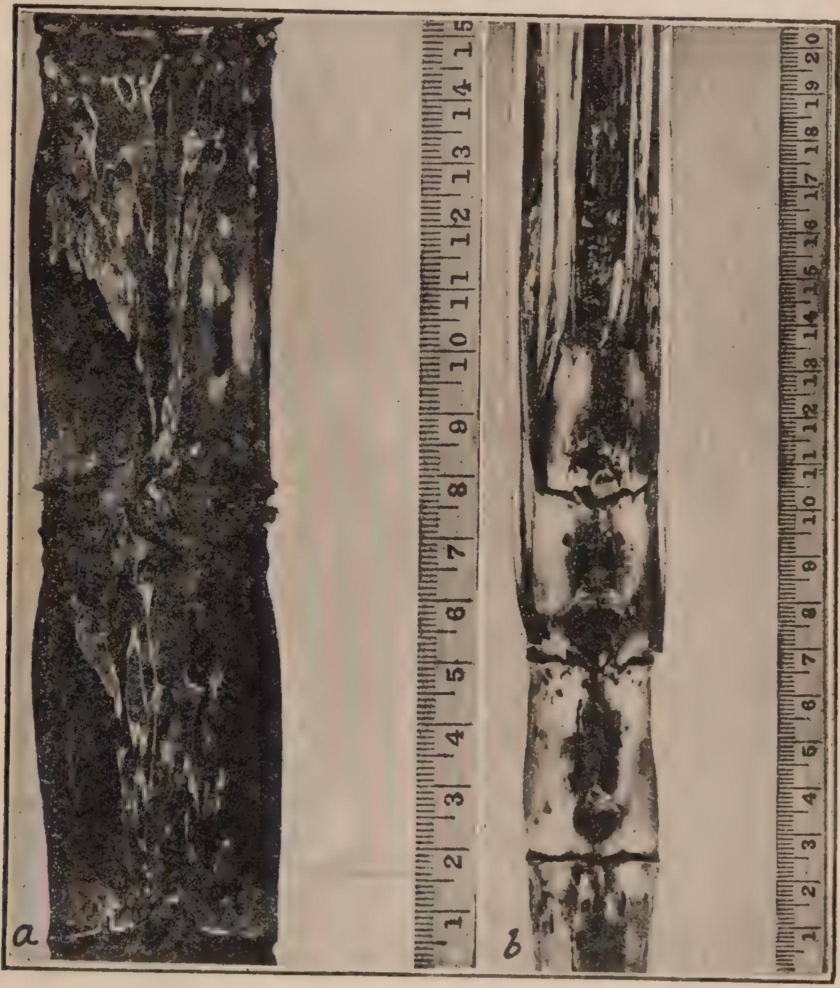

Fig. 1.—Stalk and portion of top of P. O. J. 2878. (*a*) showing cavities due to Pokkah-boeng; (*b*) showing cavities in stem immediately below the leaf spindle and rotting of the main sprout due to severe infection of Pokkah-boeng.

Pokkah-boeng is very similar to the "twisted top" of sugar cane, which Lee (1928) found to be prevalent in Hawaii in 1928, (fig. 2 a), the two diseases being very nearly alike externally in certain phases of their development. Twisted, knotted and tangled-top conditions may accompany the two diseases and these conditions make it difficult for those unfamiliar with the diseases to determine which of the two is present in the field. Careful examination, however, will show that there are marked differences between Pokkah-boeng and twisted top. The twisted, knotted and tangled-top condition in Pokkah-boeng is always associated with the formation of chlorotic areas accompanied with reddish brown spots or streaks in them at the base of the leaves. In the case of "twisted top" although chlorotic areas are to be found there is an apparent lack of reddish discoloration in them. Furthermore, the two diseases differ fundamentally as to their causal agents. According to Wakker and Went (1898) bacteria were for some time considered responsible for Pokkah-boeng, but since bacteria on inoculation failed to reproduce the disease, the trouble

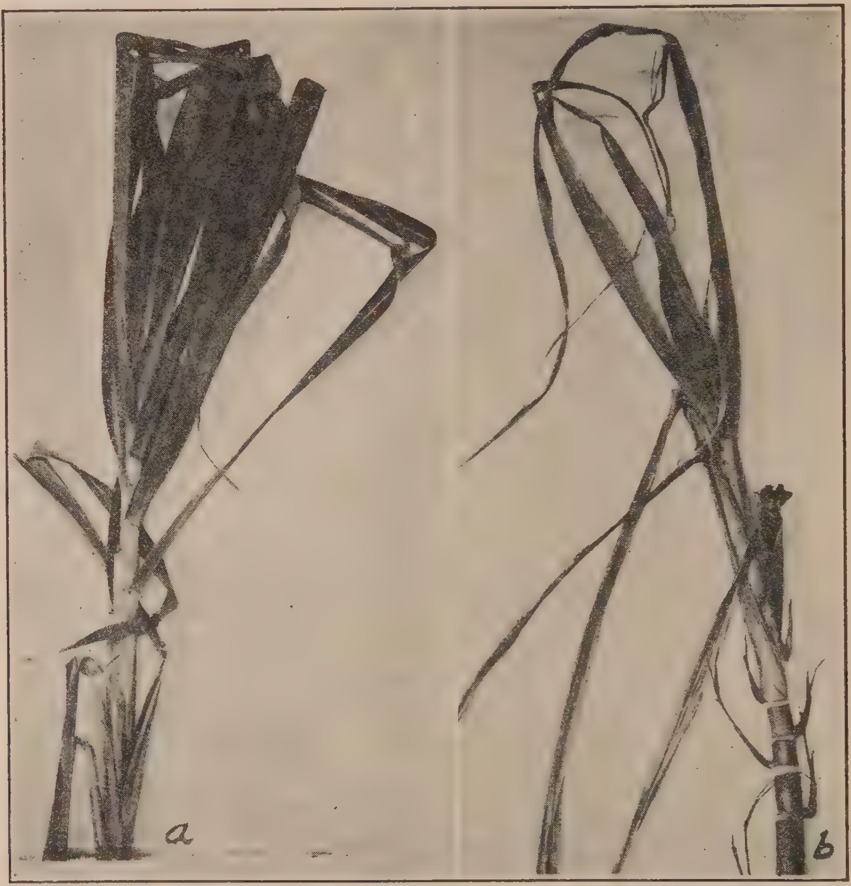

Fig. 2.—Tops of seedling cane variety and P. O. J. 2878. (*a*) affected with mild attack of twisted top due to mechanical cause ×1/4; (*b*) showing twisted top due to Pokkah-boeng produced by inoculation ×1/4. Photograph taken four weeks after inoculation.

was then regarded as being due to purely mechanical causes. Bolle (1927) in his studies of the disease during its serious outbreak in Java found definitely that the cause of Pokkah-boeng is the fungus *Fusarium moniliforme* Sheldon. Bolle's (1927) finding was later confirmed by Priode (1929) who reported that Pokkah-boeng is present in Cuba and that *F. moniliforme* is responsible for the trouble. Lee (1928) in his exhaustive experimental studies on the Hawaiian twisted top believes that the form found in Java and the Philippines might be a case of more severe form and thus feels doubtful about considering the disease to be infectious. According to this investigator twisted top is purely from mechanical cause and the disease can be easily produced at will and is non-infectious. Priode (1929), however, defines clearly that Pokkah-boeng and twisted top are two distinct types of disease. Accordingly Pokkah-boeng is caused by specific parasitic fungus and twisted and tangled top is caused by mechanical friction. Our experience with the twisted and tangled top in the Philippines seems to indicate that it is induced by either mechanical or physiological disturbance. The physiological disturbance is induced by environmental factor.

Teodoro (1927) reported that Pokkah-boeng was present in the Philippine Islands. The disease referred to by him, however, seems to be similar to the twisted top disease described by Lee (1928) (fig. 2 a) and not to *Fusarium* Pokkah-boeng (fig. 1 a and b). Lee (1928) reports the prevalence of twisted top on P. O. J. 2878 and P. O. J. 2883 and further states that the disease is apparently non-infectious.

The writer made isolations of the causal of Pokkah-boeng and a species of *Fusarium* was consistently obtained. Attempts were made to inoculate plants in the fields, by injecting with a hypodermic syringe into the leaf spindle, suspension of spores in sterile water. In a week or so the disease appeared (fig. 2 b). A more detailed study of the relation of the Philippine *Fusarium* to Pokkah-boeng and its identity with *F. moniliforme* is being undertaken.

So far as the writer knows, the disease has not been found to occur on Philippine commercial cane varieties. Whether or not they are susceptible to the disease remains to be seen.

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THE PROXIMATE CHEMICAL ANALYSIS OF PHILIPPINE FOODS AND FEEDING STUFFS: III[1]

F. T. ADRIANO, H. T. RAMOS AND L. A. YNALVEZ
Of the Department of Agricultural Chemistry

This paper is a continuation of the series dealing with the proximate chemical analysis of Philippine foods and feeding stuffs, the first two papers of which have been published in this journal (1925, 1929).

In 1928, the senior author and Dr. F. O. Santos prepared a compilation of the chemical composition of Philippine food materials. This work was undertaken in response to a demand for information on the subject. The data reported in this compilation is far from complete as only the food materials which had been investigated could be included. It is the purpose of this series of papers of which the present work is the third, and of further studies on the subject that are at present being carried out in this laboratory to make the data on chemical analysis of Philippine foods and feeding stuffs as complete as possible. These data should be of special value in nutritional investigations.

Some of the earlier results obtained have been revised as the use of more refined apparatus and more accurate methods have revealed errors. Also, when a larger number of analyses is reported, the data becomes more reliable.

The investigation is being extended to the study of other food materials and the results to be obtained will be reported in subsequent papers.

With certain modifications, the methods of analysis given by the *Association of Official Agricultural Chemists* were followed.

The data reported in this paper covers the analysis of fifty samples of root crops and forty-five samples of vegetables. The results are given in the table.

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[1] Experiment Station contribution No. 765 Received for publication July 15, 1931.

TABLE 1

The proximate chemical composition of Philippine foods

SAMPLE	REFUSE	EDIBLE PORTION	MOISTURE	ASH	CRUDE FATS (ETHER EXTRACT)	CRUDE PROTEIN (N × 6.25)	CRUDE FIBER	STARCH	N. F. E. (CARBO-HYDRATES)	CALORIFIC VALUE PER KGM.
I. *Root crops*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
1. Arrowroot; Araro, (Tag.); *Maranta arundinacea* Linn.	10.03	89.97	74.44	1.31	0.39	1.29	2.08	18.66	20.49	930
2. Canna, edible; *Canna edulis* Ker.	6.14	93.86	80.49	1.86	0.27	0.62	0.64	9.31	16.12	710
3. Cassava; Camoteng-kahoy, (Tag.); *Manihot utilissima* Pohl.										
a. Aipin mangi variety	17.04	82.96	62.97	1.18	0.27	0.63	0.88	27.36	34.07	1,450
b. Aipin valencia variety	28.02	71.98	68.92	1.10	0.12	1.14	0.95	22.99	27.77	1,200
c. Angular variety	14.92	85.08	61.36	1.22	0.46	0.60	0.61	28.94	35.75	1,530
d. Cassavae sinkong manis variety	15.29	84.71	58.53	2.07	0.26	2.08	1.18	30.07	35.88	1,580
e. Kapo White variety	13.41	86.59	62.88	1.87	0.30	2.67	0.85	27.45	31.43	1,430
f. Mandioca basiorao variety	16.05	83.95	74.25	1.40	0.10	0.42	0.62	20.68	23.21	980
g. Mandioca Sao Pedro Preto variety	22.23	77.77	59.68	1.25	0.35	0.57	0.87	31.89	37.28	1,580
h. Rough Intermediate variety	21.83	78.17	61.82	1.41	0.22	0.57	0.86	31.85	35.12	1,480
4. Dasheen; *Colocasia* sp.										
a. Lasuna variety	13.43	86.57	74.19	1.35	0.56	1.35	0.49	18.39	22.06	1,010
b. Los Baños dasheen variety	11.89	88.11	70.55	1.52	0.30	2.19	0.59	18.10	24.85	1,140
c. Malabon pula variety	10.16	89.84	74.14	1.51	0.52	2.00	0.82	14.20	21.01	990
d. Malabon pute variety	7.59	92.41	81.50	1.22	0.17	1.17	0.70	9.78	15.24	690
5. Ginger; Luya, (Tag.); *Zingiber officinale* Rosc.										
a. Large variety	5.05	94.95	86.28	2.48	0.60	0.89	0.96	7.20	8.79	450
b. Small variety	15.24	84.76	74.16	2.08	0.65	2.33	1.05	17.42	19.73	970
6. Lima-lima, (Tag.); *Dioscorea pentaphylla* Linn.	9.26	90.74	79.98	1.13	0.17	2.26	0.40	14.39	16.06	770
7. Mataybang, Kirini, or Pakit, (Tag.); *Dioscorea luzonensis* Schauer.	8.71	91.29	64.96	0.87	0.88	3.18	0.85	24.96	29.26	1,410
8. Nami, (Tag.); Namo, (Bicol); kolot, karot, (Vis.); Karot, (Ilo.); *Dioscorea hispida* Dennstedt.	14.61	85.39	80.60	0.32	0.11	2.18	0.69	10.17	16.10	760
9. Palauan, (Vis.); Galiang, (Bicol and Tag); *Cyrtosperma merkusi* Schott	10.01	89.99	69.32	1.40	0.42	0.72	1.43	19.11	26.71	1,160
10. Radish; Labanos, (Tag.); *Raphanus sativus* Linn.	8.89	91.11	94.26	1.01	0.58	0.59	0.93	0.18	2.63	190
11. Sinkamas, (Tag.); Linkamas, (Ilo.); Tinkamas, (Bicol); *Pachyrrhizus erosus* Urb.	4.92	95.08	90.10	0.55	0.28	0.90	0.74	6.09	7.43	370
12. Sweet potato; camote, (Tag.); *Ipomoea batatas* (Linn.) Poir.										
a. Binandera variety	17.38	82.62	66.68	2.11	0.34	1.37	0.94	23.32	28.56	1,260
b. Blo seedlings variety	11.35	88.65	64.19	1.22	0.61	0.99	0.94	29.04	32.05	1,410
c. Iningkanto variety	16.87	83.13	65.12	1.12	0.17	0.91	0.85	25.17	31.83	1,360
d. Kinangkong variety	16.32	83.68	66.57	1.17	0.38	0.87	0.91	25.83	30.10	1,310
e. Manila pula variety	16.33	83.67	73.78	0.99	0.21	1.42	0.51	19.15	23.09	1,020
f. New Jersey variety	16.98	83.02	61.21	2.11	0.13	1.47	1.04	29.08	34.04	1,470
g. Samar Big Yellow variety	16.00	84.00	61.28	1.59	0.29	1.30	1.03	28.78	34.51	1,500
13. Taro; Gabi, (Tag.); *Colocasia esculentum* Schott										
a. Bininting dalaga variety	6.73	93.27	58.12	1.05	0.79	1.37	0.61	29.59	38.06	1,690
b. Inahas variety	6.02	93.98	62.01	1.45	0.39	1.28	0.68	28.22	34.19	1,490
c. Ligao (wild) variety	17.63	82.37	71.50	1.41	0.34	0.85	1.18	23.36	24.72	1,080
d. Songsong variety	9.25	90.75	74.02	1.66	0.21	1.52	0.79	17.56	21.80	980

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	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
14. Tukal; Pulao; (Tag.); *Nymphaea nouchali* Burm.	22.25	77.75	52.59	1.43	0.88	0.42	1.16	34.50	43.52	1,860
15. Turmeric; Dilao, (Tag.); *Curcuma longa* Linn.	14.86	85.14	87.75	1.32	0.67	0.53	0.59	7.72	9.14	460
16. Tugue, (Tag.); Kamiging, (Bicol); Tugui, (Ilo.); Bolot, Borot, (Vis.); *Dioscorea esculenta* Burkill										
a. Hand-shaped variety	10.38	89.62	77.20	0.83	0.23	1.20	0.61	10.77	19.93	890
b. Large cylindrical variety	8.25	91.75	74.81	1.18	0.60	1.78	0.67	10.53	20.96	990
c. Small cylindrical variety	8.68	91.32	72.77	1.13	0.32	1.96	0.85	18.05	22.97	1,050
d. Potato-like variety	7.92	92.08	70.47	1.20	0.07	2.10	1.01	21.55	25.15	1,120
e. Round variety	7.66	92.34	74.35	1.34	0.08	3.00	0.49	10.97	20.74	980
f. Wild variety, Tongo, (Tag.)	9.30	90.70	69.55	0.71	0.19	1.78	1.15	20.37	26.62	1,180
17. Yam; Ubi, (Tag.); *Dioscorea alata* Linn.										
a. Cebu variety	7.94	92.06	74.83	1.08	0.14	1.97	0.75	17.64	21.23	960
b. Dinugo (Purple) variety	3.67	96.33	70.79	1.40	0.19	2.23	1.12	19.46	24.27	1,100
c. Hinaligue variety	6.98	93.02	74.12	1.23	0.17	2.30	1.57	17.13	20.61	960
d. Medium purple variety	4.72	95.28	73.95	1.35	0.06	1.72	1.04	18.31	21.88	970
e. Sinambinay (white) variety	4.88	95.12	74.01	1.30	0.24	1.86	0.74	17.73	21.85	990
f. Sinawa variety	5.66	94.34	70.59	1.27	0.45	2.25	0.73	20.33	24.71	1,150
18. Yautia; *Xanthosoma sagittifolium* Schott										
a. My Lady variety	5.45	94.55	54.30	2.64	0.36	2.04	0.78	37.22	39.88	1,750
b. Rolliza variety	11.55	88.45	68.35	2.73	0.32	1.53	0.57	22.67	26.44	1,180
c. San Fernando Po	6.59	93.41	64.78	1.89	0.39	1.97	0.85	26.40	30.12	1,350
II. *Vegetables*										
Bulbs:										
1. Garlic; bauang (Tag., Ilo.); *Allium sativum* L.	15.83	84.17	76.74	0.93	1.96	1.58	1.63	0.51	17.16	950
2. Onion; sibuyas (Tag.); lasona (Ilo.); *Allium cepa* L.	10.19	89.81	90.45	0.37	0.68	1.55	0.76	2.72	6.19	380
Average for bulbs	13.01	86.99	83.60	0.65	1.32	1.57	1.02	1.62	11.68	670
Flowers:										
1. Banana; saging (Tag.); saba (Ilo.); *Musa sapientum* L.	55.56	43.45	91.24	1.51	0.65	2.42	2.29	0.71	1.89	240
2. Katuray (Tag.); katuday (Ilo.); *Sesbania grandiflora* Pers.	12.34	87.66	90.71	0.41	0.41	1.42	0.06	2.93	6.99	380
3. Squash; kalabasa (Tag.); karabasa (Ilo.); *Cucurbita maxima* Dch.	28.56	71.44	90.83	1.65	0.47	2.80	0.73	0.90	3.47	310
Average for flowers	32.15	67.52	90.93	1.19	0.51	2.21	1.03	1.51	4.12	310
Fruits:										
1. Calamismis (Tag.); pal-lang (Ilo.); *Psophocarpus tetragonolobus* (L.) D. C.	5.00	95.00	87.42	1.08	0.96	3.80	2.53	2.70	4.21	430
2. Cardis (Ilo.); kadios (Tag.); *Cajanus indicus* Spr.	17.80	82.20	82.68	1.14	0.26	3.93	2.24	6.34	9.75	590
3. Cowpea; paayap (Tag.); otong (Ilo.); *Vigna sinenses* Savi.	19.49	80.51	85.76	0.84	0.24	3.21	2.66	5.69	7.29	450
4. Eggplant; talong (Tag.); tarong (Ilo.); *Solanum melongena* L.	12.60	87.40	93.23	0.74	1.72	1.03	1.78	0.25	1.50	260
5. Opo (Tag.); tabuñgan (Ilo.); *Lagenaria leucantha* Rby.	16.95	83.05	95.43	0.33	0.04	0.35	0.44	1.57	3.41	160

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	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
6. Otong-balatong (Ilo.); *Phaseolus calcaratus*	15.13	84.87	87.56	0.13	1.79	1.09	3.15	0.43	2.28	470
7. Pakak (Ilo.); breadfruit (Eng.); *Artocarpus cummunis* Por.	46.99	53.01	87.72	1.22	0.65	3.08	2.63	2.27	4.70	380
8. Parda (Ilo.); batao (Tag.); *Dolicho lablab* L.	55.10	44.90	88.74	1.05	0.77	0.46	2.54	0.29	6.44	350
9. Paria (Ilo.); ampalaya (Tag.); *Momordica charantia* L.	19.09	80.91	93.56	0.99	0.56	0.62	1.73	0.29	2.54	180
10. Patani (Ilo., Tag.); *Phaseolus lunatus* L.	66.27	33.73	64.21	2.01	0.89	4.51	3.17	0.44	25.21	1,300
11. Patola (Tag.); kabatiti (Ilo.); *Luffa acutangula* Rxb.	20.03	79.97	95.56	0.34	0.19	0.60	0.28	1.85	3.03	170
12. Pepper; sili (Tag., Ilo.); *Capsicum annum* L.	5.74	94.26	91.65	0.87	0.25	2.02	2.09	1.32	3.12	230
13. Sitao (Tag.); banor (Ilo.); *Vigna sinensis* Var.	3.95	96.05	86.73	0.86	0.22	3.36	3.15	0.29	5.68	390
14. Squash; kalabasa (Tag.); karabasa (Ilo.); *Cucurbita maxima* Dch.	32.29	67.71	89.55	0.88	0.75	1.77	0.71	4.64	6.34	400
15. Tamarind; sampaloc (Tag.); salamagi (Ilo.); *Tamarindus indicus* L.	21.27	78.73	69.39	1.57	0.32	2.25	1.19	3.34	25.28	1,160
16. Tomato; kamatis (Tag.); *Lycopersicum esculentum* Mill.	0	100.00	96.60	0.69	0.25	0.53	0.79	0.57	1.14	90
Average for fruits	22.36	77.64	87.49	0.92	0.65	2.04	1.95	2.02	7.24	440
Leaves:										
1. Cabbage; repollo (sp.); *Brassica oleracea* Var.	11.39	88.61	92.47	0.76	0.47	2.14	1.36	1.74	2.80	250
2. Camote (Tag., Ilo.); sweet potato (Eng.); *Ipomea batatas* L.	18.14	81.86	84.34	1.66	0.46	2.93	1.49	0.85	9.12	540
3. Cassava; camoteng-kahoy (Tag.); kamote moro (Ilo.); *Manihot utilissima* Pohl.	9.13	90.87	86.25	1.65	0.36	4.80	0.99	3.10	5.95	470
4. Celery; kinchay (Chi.); *Apium graveoleus* L.	20.87	79.13	90.70	2.28	1.02	2.41	0.78	0.50	2.81	310
5. Cowpea; paayap (Tag.); otong (Ilo.); *Vigna sinensis* Savi.	16.06	83.94	89.15	1.19	0.56	3.12	1.65	2.44	4.33	360
6. Garlic; bauang (Tag., Ilo.); *Allium sativum* L.	5.27	94.73	84.40	1.13	0.27	2.20	1.82	3.81	10.18	530
7. Kalunay; kolitis (Tag.); siitan (Ilo.); *Amaranthus viridis* L.	9.51	90.49	87.33	4.06	0.57	4.50	1.32	0.42	2.22	330
8. Kangkong (Tag.); balañgeg (Ilo.); *Ipomoea reptans* Poir.	14.45	85.55	91.33	1.58	0.31	4.40	0.96	0.51	1.42	270
9. Lettuce; lechuga (Sp.); *Luctuca sativa* L.	8.93	91.07	92.65	1.55	0.24	1.14	0.62	1.15	3.80	220
10. Malungay (Tag.); marungay (Ilo.); *Moringa oleifera* Lam.	32.55	67.45	76.38	2.53	2.94	4.95	1.45	0.47	11.75	960
11. Mustard; mostaza (Sp.); *Brassica juncea* L. Var.	4.75	95.35	92.99	1.57	0.21	0.83	0.87	0.22	3.53	200
12. Onion; sibuyas (Tag.); lasona (Ilo); *Allium cepa* L.	20.36	79.64	91.09	0.72	1.83	2.62	1.61	1.11	2.13	360
13. Opo (Tag.); tabuñgao (Ilo.); *Lagenaria leucantha* Rby.	20.64	79.36	85.59	2.25	0.02	3.04	1.23	0.76	7.87	450
14. Pako (Tag., Ilo.); *Athyrium esculentum* Cap.	20.76	79.24	85.45	2.53	2.07	3.52	2.61	0.94	3.82	490
15. Paria (Ilo.); ampalaya (Tag.); *Momordica charantia* L.	48.22	51.78	84.71	2.82	0.11	0.47	1.72	1.11	10.17	450
16. Pechay; *Brassica chenensis* L.	20.36	79.64	94.46	1.20	0.16	1.73	0.66	0.48	1.79	160
17. Pepper; sili (Tag., Ilo.); *Capsicum annum* L.	16.44	83.56	85.59	2.25	1.92	5.36	0.70	1.69	4.18	570
18. Purslane; ulasiman (Tag.); ñgalug (Ilo.); *Portulacca oleracea* L.	35.56	64.44	92.34	2.45	0.34	2.28	0.91	0.80	1.68	190
19. Squash; kalabasa (Tag.); karabasa (Ilo.); *Cucurbita maxima* Dch.	61.94	38.06	92.13	0.13	0.86	2.87	3.85	0.07	0.16	200

SAMPLE	REFUSE	EDIBLE PORTION	MOISTURE	ASH	CRUDE FATS (ETHER EXTRACT)	CRUDE PROTEIN (N × 6.25)	CRUDE FIBER	STARCH	N. F. E. (CARBO-HYDRATES)	CALORIFIC VALUE PER KGM.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
20. Tañgo (Chi.); *Crysanthermum coronarium* L.	26.91	73.09	93.12	1.17	0.41	0.50	0.62	1.17	4.18	230
21. Tamarind; sampaloc (Tag.); salamagi (Ilo.); *Tamarindus indicus* L.	16.88	83.12	80.54	1.33	1.34	0.80	3.36	2.24	12.63	680
22. Unsoy (Tag.); coriander (Eng.); *Coriandrum sativum* L.	20.00	80.00	84.57	2.83	0.79	2.67	1.26	2.42	7.88	510
Average for leaves	20.86	79.14	88.11	1.76	0.78	2.73	1.45	1.30	5.20	400
Roots:										
1. Radish; rabanus (Sp.); *Raphanus sativus* L.	25.95	74.05	94.36	0.74	0.40	0.40	0.63	0.17	3.47	200
Shoots:										
1. Bamboo: *Bambosa spinosa* Rxb.	50.00	50.00	90.48	0.86	0.70	2.63	0.71	1.03	4.62	360

*a*Tag. = Tagalog
Ilo. = Ilocano
Chi. = Chinese
Sp. = Spanish

STUDIES ON THE METHODS OF FEEDING DUCKS[1]

GAUDENCIO B. CRUZ

WITH ONE CHART

It is the common belief among duck raisers that the only way to raise the birds profitably is to feed them snails; *Vivipara angularis* Müller (Tagalog, *susong pangpang*) is a species preferred. Those who raise ducks in numbers depend to a great extent, upon these snails for feed. Because of this practice, the duck industry in the Philippines is confined largely to some localities in Bulacan, Pampanga, Rizal and Laguna in Luzon, and in Iloilo in the Visayan Islands that are near bodies of fresh water, where snails can be easily procured (Philippine Census, 1918).

In times of scarcity of this species of snails, the egg production of ducks practically stops and the flocks decrease rapidly. The situation forces the duck raisers to face the question of finding a substitute for snails for feed for the birds.

Dried shrimps and fish meal are used extensively in the College of Agriculture as supplements in the chicken ration for growth of the chicks and for egg production. These supplements have produced satisfactory results. A study on the use of these feeds for duck production appears to be timely as the results obtained may help duck producers in providing an economical and satisfactory substitute for snails in the rations.

Ashbrook (1917) reported that fish meal is a very effective supplement to grain ration for pigs.

Embody (1918) fed shrimps in the form of meal to fish in combination with different animal and vegetable proteins. He found that a combination of meat meal and shrimps with a small amount of flour is the best and most economical supplement.

Fronda (1919) compared the effects of animal and plant proteins on the egg production of hens. He used snails to supply animal and copra meal to supply plant proteins in the ration. He reported that the snail-fed-hens averaged 53.75 eggs a year while the copra-meal fed produced only an average of 36.25 eggs. Working with ducks, Goseco (1921) reported that nine snail-fed-ducks produced an average of 71.95 eggs a duck, while the nine copra meal-fed-ducks produced an annual average of 24.29 eggs a duck.

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[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 403. Experiment Station contribution No. 766. Prepared in the Department of Animal Husbandry under the direction of Assistant Professor F. M. Fronda.

Santiago (1926) reported that on growing pigs good results were obtained by using dried shrimps as supplement to corn and rice bran in the proportion of from six-tenths to one part dried shrimps to a mixture of six parts corn and thirteen parts rice bran. Serrano (1928) found that dried shrimps are much better than copra meal when used as supplement in rations for laying hens.

Fronda (1929) concluded that both dried shrimps and fish meal produced satisfactory results when used as supplements in rations for laying hens in the proportion of five per cent of the ration. He found also that both dried shrimps and fish meal produced well developed yearlings, which in both cases were similarly attractive and vigorous.

The experiment was conducted with the following objects: To determine the method of feeding (*a*) on the growth, and (*b*) on the egg production of ducks. The experiment with ducklings was run for nineteen weeks beginning August 18, 1929, and ending on February 3, 1930. The experiment dealing with laying ducks was conducted from February 4, 1930, to February 3, 1931.

MATERIALS AND METHODS

Plan of the experiment. The values of dried shrimps, of fish meal, and of fresh snails were compared in this experiment. The ducklings were divided into three lots, lot I, lot II, and lot III. The birds fed with dried shrimps constituted lot I, those fed with fish meal were placed in lot II and those fed with snails were placed in lot III. Lot I was given dried shrimps to the amount of twenty per cent of the ration. Lot II was given fish meal, which was twenty per cent of the ration. Lot III was given fresh snails. All the birds in this experiment received practically the same attention and care. When the drakes were twelve weeks old, they were separated from the females and turned over to the Poultry Division.

Feeding, care, and management. One hundred and eighty ducklings (one-day old) divided into lots of sixty, thirty of which were males and thirty females, were used in this experiment. The ducklings were legbanded and were confined in three different compartments. On the second day after hatching, the ducklings were given the feed prescribed for each lot.

In lot I, the ducklings were given a mash mixture consisting of twenty parts by weight of corn meal, twenty parts of dried shrimps and sixty parts of rice bran. The ducklings in lot II were given by weight, twenty parts of corn meal, twenty parts of fish meal and sixty parts of rice bran. The only difference between the feeds of lot I and lot II was that fish meal was used in lot II and dried shrimps in lot I. In both lots I and II the mixture was given wet, three times a day and at 11:00 o'clock at night until the ducklings were three weeks old when the feeding at night was stopped. This feeding was followed until the end of the experiment.

The ducklings in lot III were given boiled "rice of corn."[2] The ducklings were fed four times during the day and two times during the night. After the first week, finely chopped fresh shrimps were given at noon instead of the boiled "rice of corn". After the ducklings were three weeks old, they were fed only once in the night. Beginning with the sixth week, feeding at night was stopped and the ration was changed to palay (unhulled rice) and cracked snails. Palay was fed morning and afternoon and cracked snails were given two times during the day. This feeding was carried on until the birds were twelve weeks old.

The feed in the three lots was given in wooden troughs. Drinking water was accessible all the time and was changed once or twice daily. As the ducklings were confined in separate compartments inside the laboratory building for four weeks, they were given finely chopped green grass every day. When the birds were transferred to the yards, they were given free access to green grass on the range.

During the brooding period the ducklings in each lot were provided with light, furnished by an ordinary "Dietz" kerosene lantern, at night to enable them to see their feed, also the lantern furnished some heat to keep them warm. The compartments were provided with rice hulls for bedding; this was changed two times a week.

Fifty-one ducks were used in the study of layers. These were divided into three lots: Lots I, II, and III with seventeen ducks to each lot. The birds were treated in the same manner as the weanling ducks.

With layers, the birds in lot III were given palay morning and afternoon, and during the day they had free access to live snails. Duck raisers of Rizal and Laguna provinces claim that fresh snails are easily digested because they contain a large percentage of water. They give this as their reason for giving the birds free access to snails. To approach as nearly as possible the "native method" of feeding ducks, the snails in this study were placed in wooden troughs containing water.

The birds in both lots I and II were given wet mash mixed in the same proportion as that used for the ducklings. They were fed three times a day, in the morning, at noon, and in the afternoon. The "native method" requires more labor and time in the preparing and giving of the feeds than either lot I or II. One thing that takes time and labor is providing a supply of fresh snails every day.

The ducks were housed temporarily in three separate pens. Yards adjoining the pens provided the birds with green feeds and a place to exercise.

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[2] "Rice of corn" is a literal translation of what the duck raisers call *bigas ng mais* (Tag.). It consists of the horny endosperm of the corn kernel, cleaned and polished. This is boiled in much the same manner as rice is cooked for the table. This ration is given in what is called the native method of feeding.

Climbing vines trained over a frame were used to protect the ducks from heavy rain and the intense heat of the sun.

Records. The ducklings were weighed weekly from the first day of the experiment until they were twelve weeks old. At this age the drakes were discarded and the ducks retained. The different amounts of feed consumed were carefully recorded. The record of the number of eggs laid by the layers was kept. The length of the time to maturity of the birds in each lot was carefully observed. The general condition of the birds was noted. Mortality records were also kept.

Prices of feeds. The prices of the feeds used upon which computations were based follow:

Corn meal	₱0.055 per kilogram
Dried shrimps	0.208 per kilogram
Fish meal	0.198 per kilogram
Palay	0.082 per kilogram
Rice bran	0.050 per kilogram
Fresh shrimps	0.150 per kilogram
Fresh snails	0.100 for every 15 kilograms

These were the current prices in the local market at the time these experiments were being conducted.

DISCUSSION OF RESULTS

Ducklings to twelve weeks old. In this experiment the weekly weights of the ducklings were used as the criterion in determining their comparative rates of growth. These weights are shown graphically in chart 1. It may be seen in this chart that the mash with shrimps as supplement has produced large gains in weight from the beginning of the experiment up to the twelfth week. The difference in the rates of growth between lots I and II and II and III is very great, and appreciable differences can be observed in the rates of growth of the ducklings in lots I and III, and II and III. The chart shows clearly the superiority of lot I over lot II and also over lot III, the "native method."

The average weights of the birds when twelve weeks old were 1,191.4 grams in lot I, 879 grams in lot II, and only 519.1 grams in lot III. There is a marked difference in the average final weights in the three lots. These weights are higher than that observed by Alcasid (1919) which was only 273.6 grams. The number of birds to each lot at the end of twelve weeks was forty-six for lot I, thirty-five for lot II, and thirty-one for lot III. The birds in lot I were more uniform and very much heavier than the birds in either of the other two lots. This shows that the mash with dried shrimps as supplement was sufficient to supply the necessary nutrients for the growth of the young ducklings, since their rate of growth up to the twelfth week was very much better than that of either lot II or III. It was also noted that the drakes grew faster than the ducks. The average weights of the drakes when twelve weeks old in lot I was 1,357.3 grams and of the ducks, 925.3 grams. The difference in weight shows that there is a considerable difference in the rates of growth between the drakes and the ducks. This difference obtained also in the other two lots, II and III. Incidentally, it might be pointed out that these average weights of the drakes compare very favorably with those reported by Fronda and Cruz (1931) who gave identical ration to the birds.

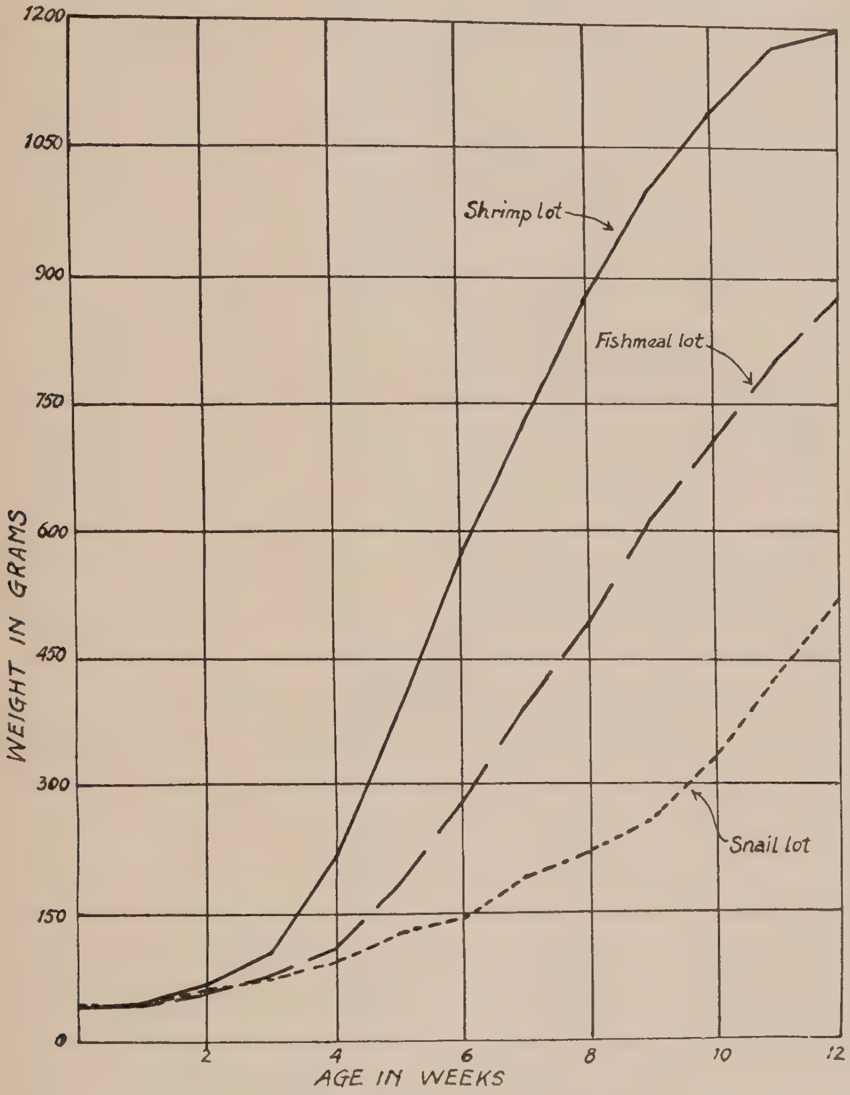

Chart I.—Showing the growth of ducklings.

The amount and cost of feeds necessary to produce weanling ducks. Table 1 shows the amount and cost of feeds consumed in lots I, II, and III. The usual rates of increase in feed consumption in all lots as the birds advanced in age were noticed. It may be observed that the amount of feed consumed in lots I and II was almost the same. This may be expected because the amount of feed given to the birds was well regulated. It may be noted that of the two feeds given; namely, fresh shrimps and "rice of corn" in lot III during the first six weeks, that the birds consumed slightly more of the shrimps than of the corn. The total amount consumed up to the sixth week was 62.50 kilograms of shrimps and 43.50 kilograms of "rice of corn." From the seventh to the twelfth week the birds consumed only 19.00 kilograms of palay. However, 540 kilograms of fresh snails were consumed during this period. Lot I consumed 224.4 kilograms of mash or 4.47 kilograms per bird and lot II consumed 162.78 kilograms of mash, or 3.83 kilograms per bird.

The total cost of feeds consumed by the birds was ₱18.54 in lot I, ₱13.12 in lot II, and ₱14.19 in lot III. The total amount of feeds consumed when computed for every 100 weanling ducks was 447.10 kilograms in lot I, 383.01 kilograms in lot II, and in lot III, 107.10 kilograms of the "rice of corn," and 46.70 kilograms of palay, 153.60 kilograms of fresh shrimps, and 1,238.30 kilograms of fresh snails. (See table 1). On this basis the total cost would be ₱36.93 in lot I, ₱30.87 in lot II, and ₱41.01 in lot III. Comparing the cost of raising the ducklings to weanling stage in the lots I, II, and III, the cost in lot III is the highest, lot I, second, and lot II, the lowest. The difference may be attributed largely to the kinds and prices of feeds used in the study. The highest cost among the individual feeds in lot III was the fresh shrimps, ₱9.37, and the lowest, the palay, ₱1.52. The native method of feeding (lot III) was found to be the most expensive.

Comparing the results of these experiments on the cost of raising one hundred weanling ducks to 12 weeks of age with that reported by Fronda and Cruz (1931); namely, ₱40.15, it is found that the cost of producing weanling ducks in the present investigation is lower by ₱3.22 in lot I, by ₱9.28 in lot II, and about the same as in lot III.

TABLE 1

Showing the amount and cost of feeds necessary to produce weanling ducks, computed for every 100 birds

FEEDS	LOT I		LOT II		LOT III	
	Quantity	Cost	Quantity	Cost	Quantity	Cost
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Mash	447.10	36.93	383.01	30.87	———	———
Rice of corn	———	———	———	———	107.10	5.89
Palay	———	———	———	———	46.70	3.82
Fresh shrimps	———	———	———	———	153.60	23.04
Snails	———	———	———	———	1238.30	8.26
Total	447.10	36.93	383.01	30.87	———	41.01

The cost of feeds necessary to produce duck pullets from weanling ducks. Table 2 shows the amount and the cost of feeds necessary to produce duck pullets from weanling ducks. There were seventeen layers in each lot. The total amount of feeds consumed in lot I was 109 kilograms, in lot II, 101.50 kilograms and in lot III, 880 kilograms. The total costs of feeds were ₱9.00 in lot I, ₱8.18, in lot II, and ₱8.88, in lot III. If these amounts were computed on the basis of 100 birds raised, the total amount of feeds would be 641.20 kilograms in lot I, 597.00 kilograms in lot II, and 5,176.50 in lot III. The total costs would be in lot I, ₱52.96, in lot II, ₱48.12, and in lot III, ₱52.28. These comparative costs differ from those given in table 1; lot III being the most expensive, lot I the second, and lot II, the least, because in lot III, from the first week to the sixth week, fresh shrimps, which are expensive, was a part of the ration. (See table 2).

Cost of producing birds and the cost of feeds consumed. Table 3 shows the cost of birds produced and the cost of feeds consumed. The selling price of drakes was computed at ₱0.60 a kilogram live weight, and the cost of the pullets was computed at ₱1.50 each. At these rates, it was found that the cost of the birds raised from each lot was:

1. Lot I	₱55.20
2. Lot II	33.78
3. Lot III	29.78

TABLE 2

Showing the cost of feeds necessary to produce pullets from weanling ducks

FEEDS	LOT I		LOT II		LOT III	
	Quantity	Cost	Quantity	Cost	Quantity	Cost
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Mash	109.00	9.00	101.50	8.18	———	———
Palay	———	———	———	———	40.00	3.28
Snails	———	———	———	———	840.00	5.60
Total	109.00	9.00	101.50	8.18	880.00	8.88
Total (computed for every 100 raised to maturity)	641.20	52.96	597.00	48.12	5176.50	52.28

The cost of feeds used was ₱27.54 in lot I, ₱21.30 in lot II, and ₱25.68 in lot III. Subtracting the cost of feed from the price of birds produced, the profit would be ₱27.66 in lot I, ₱12.48 in lot II, and only ₱4.10 in lot III. The feed cost per pullet raised to maturity was ₱0.598 in lot I, ₱0.610 in lot II, and ₱0.798 in lot III. These results show that lot I is more profitable than either lot II or III. Lot III was the most expensive of the three lots, and it also required the most labor and time to feed.

Lot I was the least expensive and it required the least labor and time, especially to prepare and give the feeds to the birds. (See table 3).

Development of the pullets raised. Table 4 shows the comparative development of the pullets raised. It may be seen in this table that the birds in the different lots did not mature at the same time. The ages at green duck stage as determined from the weights and external appearance of the birds were 84 days for those in lot I, 103 days for those in lot II, and 125 days for those in lot III. The age when the first egg was laid was 142 days in lot I, 160 days in lot II, and 176 days in lot III. These periods are shorter than the one reported by Alcasid (1919) which was 195 days. The method of feeding employed and the kind and quality of the feeds used may have had a marked influence upon the rate of maturity of the birds raised. The number of eggs collected up to the nineteenth week of age was 160 eggs in lot I, 45 eggs in lot II, and none in lot III. The value of the eggs laid up to the nineteenth week of age at ₱0.045 an egg was ₱7.56 in lot I, and ₱2.03 in lot II. If these values were computed on the basis of 100 pullets, the total number of eggs laid up to the nineteenth week of age would be 988 eggs in lot I, and 264 eggs in lot II. The total value would be ₱44.47 in lot I, and ₱11.91 in lot II. The birds in lot III had not laid any eggs up to this age. These data show that the birds raised according to the "native method" (lot III) matured later than the birds in lots I and II. (See table 4).

TABLE 3

Cost of producing birds and the cost of feeds consumed

ITEMS	LOT I		LOT II		LOT III	
	Weight	Value	Weight	Value	Weight	Value
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Value of drakes at 12 weeks old[a]	33.60	20.70	13.80	8.28	7.14	4.28
Value of pullets before laying[b]	———	34.50	———	25.50	———	25.50
Total value	33.60	55.20	13.80	33.78	7.14	29.78
Cost of feed	333.40	27.54	267.28	21.30	1545.50	25.68
Value of birds over the cost of feed	———	27.66	———	12.48	———	4.10
Cost of feed per pullet raised	7.24	0.59	7.63	0.61	49.8	0.79

[a] The drakes were valued at ₱0.60 a kilograms live weight.

[b] The pullets were valued at ₱1.50 each.

TABLE 4

Development of the pullets raised

ITEMS	LOT I	LOT II	LOT III
Dated hatched	August 18, 1929	August 18, 1929	August 18, 1929
Weight at hatch	36.50 grams	36.40 grams	38.80 grams
Date at which the ducklings reached 1 kilogram live weight	November 12, 1929	December 1, 1929	December 23, 1929
Age when 1 kilogram live weight was reached	84 days	103 days	125 days
Date when first egg was laid	January 8, 1930	January 26, 1930	February 4, 1930
Age when first egg was laid	142 days	160 days	176 days
Number of eggs collected up to 19 weeks of age	160	45	——
Value of eggs laid up to 19 weeks of age at ₱0.045	₱7.56	₱2.03	——
Number of eggs collected from every 100 pullets at 19 weeks (computed)	988	264	——
Value of eggs laid computed for every 100 pullets at 19 weeks	₱44.47	₱11.91	——

Mortality. The number of birds that died were 14 in lot I, 25 in lot II, and 29 in lot III. The percentage of mortality was 23.33 in lot I, 41.66 in lot II, and 48.33 in lot III. These percentages are much higher than that reported, 10 per cent, by Fronda and Cruz (1931). During the fifth week the mortality of ducklings in the three lots was high because of deaths due to accident. That period occurred at the time when typhoons and heavy rains were prevalent so that a great number of deaths was the result of the ducklings getting chilled.

Egg production. The number of eggs laid are given in table 5. It is shown in this table that the birds fed with dried shrimps as supplement laid a larger number of eggs than those which were fed mash with fish meal as supplement (lot III). A similar difference is evident when lot I is compared with lot III, the palay and fresh-snail-fed birds. The differences between the total number of eggs produced in the three lots were appreciably great. It will be noted also that the monthly egg production in lot I was much higher than in the other two lots. The sudden decrease of egg production from November up to January 3 in all three lots was due, probably, to the fact that the birds molted during that time. The total number of eggs produced in one year was 3,267 in lot I, 1,656 in lot II, and 1,187 in lot III. The average production per bird was 225.35 eggs in lot I, 102.23 eggs in lot II, and 92.74 eggs in lot III. These averages are very much higher than that reported by Goseco (1921). It may be seen that the maximum productions were attained in lot I from July 4 to August 3, 99.08 per cent; in lot II from February 4 to March 3, 66.59 per cent; and in lot III from May 4 to June 3, only 63.97 per cent. It may be mentioned that in lot I there was one month when no dried shrimps were fed to the birds, instead, meat scraps were given. This was a compulsory change as dried shrimps could not be procured during this period. (See table 5).

TABLE 5

The comparison of the number and percentages of eggs laid (February 4, 1930 to February 3, 1931)

PERIODS	LOT I		LOT II		LOT III	
	Number of eggs	Per cent	Number of eggs	Per cent	Number of eggs	Per cent
1930						
February 4 to March 3	288	60.50	317	66.59	161	33.80
March 4 to April 3	434	87.50	289	52.94	289	54.84
April 4 to May 3	421	87.77	121	23.73	68	18.89
May 4 to June 3	279	60.00	174	35.08	238	63.97
June 4 to July 3	311	69.11	199	41.44	188	52.22
July 4 to August 3	430	99.08	191	38.51	148	39.78
August 4 to September 3	240	55.30	92	18.55	14	3.64
September 4 to October 3	358	85.24	89	18.54	12	3.33
October 4 to November 3	261	60.14	144	26.82	146	39.25
November 4 to December 3	48	11.43	0	——	0	——
1931						
December 4 to January 3	15	3.74	0	——	0	——
January 4 to February 3	182	45.21	40	8.08	23	6.19
Total number of eggs laid	3,267	——	1,656	——	1,187	——
Average number laid per bird	225.35	——	102.23	——	92.74	——

The amount and cost of feeds consumed by layers. Table 6 shows the amount and cost of feeds consumed by the layers in the three lots, I, II, and III. It may be seen from this table that the total amount of feeds consumed was 665.40 kilograms, or 46.58 kilograms of mash per bird in lot I, 593.20 kilograms, or 36.62 kilograms of mash per bird in lot II, and 101.4 kilograms, or 7.93 kilograms of palay per bird and 3,166 kilograms, or 255.16 kilograms of fresh snails per bird in lot III. If these quantities were computed on the basis of 100 layers, the total amount of feeds was 4,658 kilograms in lot I, 3,661.70 kilograms of mash in lot II, and 792.90 kilograms of palay and 25,515.80 kilograms of fresh snails in lot III. These results show that the birds in lot I consumed more feeds than those in lot II. This may show that ducks find dried shrimps more palatable than fish meal. Lot III consumed the largest amount of feeds. The reason for this is that the feeds given to this lot were bulky with a small amount of nutrients content. It may be noted also that lot III did not receive snails throughout the year. The reason for this was that snails during two periods (September 4 to October 3 and November 4 to February 3) were hard to procure and not suitable for feeding ducks, because in this season the snails eat algae, which gives them a taste that is disagreeable to ducks. Furthermore, the algae-eating snail may be poisonous to the ducks, for local duck raisers claim that there are many deaths among ducks that eat these snails.

The total costs of feeds were ₱54.96 in lot I, ₱47.81 in lot II, and ₱29.21 in lot III. When computed on the basis of 100 birds, the costs of egg production were ₱384.75 in lot I, ₱295.03 in lot II, and ₱235.12 in lot III. The difference in the total value of these feeds may be due to the different amounts of feed consumed and the costs of protein supplements in the ration used, as these would affect the value of one kilogram of the ration.

Referring to tables 5 and 6, the amount and cost of feeds consumed to produce a dozen eggs may be computed. To obtain these figures, the total amount of feeds consumed was divided by the total number of eggs produced; the quotient multiplied by 12 gave the amount of feeds needed to produce a dozen eggs. The products when multiplied by the price of one kilogram of feeds gave the cost of feeds consumed for a dozen eggs produced. On the average, it required only 2.45 kilograms of mash, costing ₱0.20, to produce one dozen eggs in lot I, 4.29 kilograms of mash, costing ₱0.34 to produce one dozen eggs in lot II, and 37.20 kilograms of feed consisting of palay and snails, costing ₱0.26 to produce a dozen eggs in lot III; hence, the most economical eggs produced were in lot I.

TABLE 6

Amount and cost of feeds consumed by layers (February 4, 1930 to February 3, 1931), computed for every 100 layers

FEEDS	LOT I		LOT II		LOT III	
	Quantity	Value	Quantity	Value	Quantity	Value
	kgm.	*pesos*	*kgm.*	*pesos*	*kgm.*	*pesos*
Mash	4658.00	384.75	3661.70	295.03	———	———
Palay	———	———	———	———	792.90	65.02
Snails	———	———	———	———	25,515.80	170.10
Total	4658.00	384.75	3661.70	295.03	———	235.12

The cost of feeds required for egg production. Table 7 shows the cost of feeds that were required in each of the three lots for egg production. All the eggs produced were valued at four and one-half centavos each. The value of eggs produced in lot I, was ₱147.02; in lot II, ₱74.54; and in lot III, only ₱53.42. Subtracting the cost of feeds from the value of eggs produced the returns above the cost of feed from each lot were ₱92.06 in lot I, ₱26.73 in lot II, and ₱24.21 in lot III. If the returns were computed on the basis of 100 layers, the total returns above the cost of feeds from each lot would be ₱634.90 from lot I, ₱165.00 from lot II, and ₱189.14 from lot III. It is obvious that of the three lots, the greatest profit expressed in value of eggs above the cost of feeds consumed was obtained from lot I. This profit from lot III was greater than from lot II. This was because of the low cost of the feeds used in lot III, and not to the number of eggs produced. (See table 7.)

TABLE 7

Showing the cost of feeds required for egg production

ITEMS	LOT I	LOT II	LOT III
Number of eggs laid	3,267	1,656	1,187
Value of eggs at ₱0.045 each	₱147.02	₱ 74.54	₱ 53.42
Amount of feeds consumed	665.4 kgm.	593.2 kgm.	3,722.4 kgm.
Cost of feeds	₱ 54.96	₱ 47.81	₱ 29.21
Value of eggs over cost of feeds	₱ 92.06	₱ 26.73	₱ 24.21
Value of eggs over cost of feed computed for every 100 layers	₱634.90	₱165.00	₱189.14

Comparison of mortality. Four birds died in lot I, one in lot II, and five in lot III. The percentages of mortality were 23.53 per cent in lot I, only 5.88 per cent in lot II, and 29.41 per cent in lot III. One of the birds in lot I, number 1919, was killed by an alimos (*Paradoxorus philippinensis* Jourdan). Five birds in lot III died in April probably because in this season the snails eat algae, which gives them a taste that is disagreeable to ducks. Furthermore, the algae-eating snails may be poisonous to the ducks, for local duck raisers claim there are many deaths among ducks that eat these snails. The cause of the other deaths was either egg-bound or eggs broken inside the body. It will be noted that the mortality among the layers in lots I and III during the year was not normal.

SUMMARY AND CONCLUSIONS

1. The results of studies on the methods of rearing ducklings and of feeding ducks for egg production are reported in this paper.

2. The birds were divided into three lots, lot I was given a supplement of dried shrimps, lot II, a supplement of fish meal, and lot III, a supplement of snails.

3. From the first to the twelfth week of the experiment appreciable differences were observed in the rates of growth of ducklings in the three lots.

4. There was a very significant difference in the different lots in the size the birds attained; at the end of the twelfth week, the birds fed with dried shrimps as supplement were the heaviest, those fed with snails were the smallest.

5. The snail-fed birds consumed the most feed and were the most expensive to raise.

6. The average feed consumption per 100 weanling ducks was approximately 447 kilograms in lot I, 383 kilograms in lot II, and 1,545 kilograms in lot III.

7. The average cost of feed to produce a weanling duck was ₱0.37 in lot I, ₱0.31 in lot II, and ₱0.41 in lot III.

8. In raising pullets from weanling ducks to maturity the feed consumption per 100 birds was found to be 641.2 kilograms in lot I, 597 kilograms in lot II, and 5,176.5 kilograms in lot III.

9. The cost of feeds required to raise 100 pullets from weanling ducks to maturity in lot I, was ₱52.96, in lot II, ₱48.12, and in lot III, ₱52.28.

10. The total cost of rearing the birds to maturity was ₱55.20 in lot I, ₱33.78 in lot II, and ₱29.78 in lot III.

11. The age at which one kilogram weight was attained was 84 days in lot I, 103 days in lot II, and 125 days in lot III.

12. The age at which the first egg was laid was 142 days in lot I, 160 days in lot II, and 176 days in lot III.

13. There was a lower mortality among the young ducks in the dried shrimps lot than in either lot II or lot III.

14. The egg production was highest in the dried shrimps lot, second in the fish meal lot, and the lowest in the snail-fed lot.

15. The average yearly feed consumption per laying duck was approximately 46 kilograms in lot I, 36 kilograms in lot II, and 263 kilograms in lot III.

16. The cost of feeds consumed per layer in one year was ₱3.85 in lot I, ₱2.95 in lot II, and ₱2.35 in lot III.

17. Of the different protein supplements used, the dried shrimps gave the highest returns over the cost of the feeds consumed.

18. Of the rations used in rearing ducks in this study, feeding with shrimps as supplement was found to be the most practical and economical, and the one to be recommended.

19. The results obtained in this study show that it is not necessary to be located near a large body of fresh water to raise ducks with profit.

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PROFESSOR AND MRS. LEWIS RALPH JONES HONOR THE COLLEGE OF AGRICULTURE AT LOS BAÑOS WITH A VISIT[1]

Professor Lewis Ralph Jones, noted American teacher and investigator in plant pathology and chairman of the Department of Plant Pathology of the University of Wisconsin at Madison, arrived in Manila on November 5, 1931 for a two weeks sojourn in the Philippine Islands. He was accompanied by Mrs. Jones. During their brief stay in the Philippines, Professor and Mrs. Jones visited the College of Agriculture at Los Baños where they were guests of the Los Baños Biological Club from noon of November 13 to forenoon of November 16. While at the College of Agriculture the distinguished visitors were entertained by Dean B. M. Gonzalez, the local "Badgers", the Los Baños Biological Club and the Society for the Advancement of Research.

After a luncheon on November 13 in Molawin Hall, given by G. O. Ocfemia, former student of the visiting savant, Professor Jones visited the departments of Entomology and Plant Pathology. Mrs. Jones and Mrs. B. M. Gonzalez visited the Lopez Elementary School in San Antonio, Los Baños. In the evening, a buffet supper was given by the Los Baños Biological Club at Molawin Hall. The supper was followed by a scientific program of the club in the Lecture Hall of the Department of Agricultural Chemistry. In this program the following papers were read and discussed:

1. "The amino-acids content of kanduli (*Arius* spp.)," by Mr. N. L. Galvez and Dr. F. O. Santos of the Department of Agricultural Chemistry.
2. "*Gumaan* driftwood (Cavanillesia)" by Mr. Luis J. Reyes, Chief, Division of Forest Products, Bureau of Forestry.

After the reading and discussion of the two papers the guest of honor, Professor Jones, was introduced by Dean Gonzalez. Professor Jones spoke on the importance of plants as experimental subjects touching on the cell theory, the discovery of protoplasm, the work of Anton de Bary on the causal relation of fungi to disease in plants, and on the researches of the Russian botanist Woronin on cellular pathology. He explained parasitism and disease in plants; and also explained the importance of the fungi as causal agents of plant diseases, that these were later on followed by the bacteria and that now the viruses are becoming increasingly important as studies on them are being made. Along with the present-day progress on plant viruses, Doctor Ocfemia's work on the bunchy-top of abacá received appreciative comments from Professor Jones.

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[1] General contribution from the College of Agriculture No. 299.

In the forenoon of November 14, Professor and Mrs. Jones visited the College of Veterinary Science and the School of Forestry. From 11:00 a. m. to 12:00 m. Professor and Mrs. Jones were speakers at the Convocation at the College of Agriculture Auditorium. Mrs. Jones described her observations of the educational systems in Russia, Japan and the United States. Following the convocation, the Wisconsin Alumni residing at Los Baños tendered a luncheon to Professor and Mrs. Jones. After the luncheon Dean Gonzalez invited Professor Jones to see the Department of Animal Husbandr . The Dean explained to him the work of the department and demonstrated to the visitor the advances that they have made in their work on the breeding of carabao, cattle and swine. In the evening the Society for the Advancement of Research, an honorary and scientific organization, honored Professor and Mrs. Jones with a formal dinner. After the dinner the annual scientific program for the initiation of newly elected active members was held in the Auditorium of the College of Agriculture with Professor Jones as the guest of honor. Professor Jones spoke on "Research in the field of plant pathology." With his address at the Los Baños Biological Club program the night before as an introduction, he addressed the Society for the Advancement of Research on biological equilibrium in nature and disease resistance in plants as a means of control of plant diseases. He explained the work at Wisconsin University on disease resistance especially that dealing with cabbage yellows (*Fusarium conglutinans*). In this Dr. J. C. Walker and other members of the staff and students were associated.

On November 15, Professor and Mrs. Jones visited a pineapple field and a picnic site in Calauan, Laguna. On the way back to the College of Agriculture Professor Jones had a chance to see varieties of Philippine bananas resistant to the wilt disease caused by *Fusarium oxysporum* (*Fusarium cubense*) as well as the most susceptible variety of banana, the Latundan. From Calauan, Professor and Mrs. Jones were accompanied by Forester Alejandro de Mesa and Ranger Mamerto Sulit to the National Botanic Garden and a little way up the slope of Mount Maquiling. Professor Jones' interest was attracted by the strangling fig, the "100 per cent utility palm," or sugar palm (*Arenga pinnata*) and many other things. In the afternoon Professor and Mrs. Jones went on short motor boat ride on Laguna de Bay. Dean Gonzalez and Doctor Villadolid, in charge of the Los Baños Limnological Station, Department of Entomology, at Mayondon, Los Baños, were among those in the party. Part of the afternoon before and after the motor boat ride was spent by Professor Jones inspecting the work of the Department of Plant Pathology. The writer's work on the bunchy-top of abacá, Fiji-transmission, and studies on mosaic disease of sugar cane and smut of sugar cane interested Professor Jones immensely. According to Professor Jones the College of Agriculture is most ideally located and the environment most conducive to productive research. In the evening Dean and Mrs. Gonzalez honored Professor and Mrs. Jones with a dinner at the Dean's home on Faculty Hill.

In the morning of November 16, before Doctors Toribio Vibar and N. G. Teodoro, of the Bureau of Plant Industry at Manila arrived to take Professor and Mrs. Jones on a trip through Batangas and Tayabas provinces, the class in Plant Pathology 1 had the great good fortune of hearing a lecture from Professor Jones on the subject of struggle for existence and survival of the fittest as shown by the plant life on Mount Maquiling.

G. O. Ocfemia
Of the Department of Plant Pathology.

ABSTRACT[1]

Comparative study on the nutritive values of phosphates, sulfates, nitrates, chlorides, and carbonates of essential metals as indicated by the growth and development of young rice plants.[2] EMILIO MACASAET. (*Thesis presented for graduation, 1927 from the College of AgricultureNo. 404; Experiment Station contribution No. 767.*)—The object of this work was to determine the comparative effects on the growth and development of young rice plants, of the phosphates, sulfates, nitrates, chlorides, and carbonates of each of potassium, magnesium, calcium, and ammonium.

Lowland rice seeds of Roxas variety were soaked in water for twenty-four hours. Then they were spread between sheets of blotting paper for another twenty-four hours to germinate. The germinated seeds were spread on paraffined bobbinet tied over the mouth of a large museum jar containing tap water. The germinator was kept in the glass chamber. When the seedlings were five centimeters high, they were mounted on cork stoppers and placed in culture bottles containing 65 cc. of the single salt solution. Culture bottles were wrapped with carbon and Manila paper and kept in the glass chamber.

Three concentrations (0.001, 0.002 and 0.004 gram-molecule) of each of the monobasic phosphate, sulfate, nitrate, chloride and carbonate of each of potassium, ammonium, magnesium and calcium were supplied singly to the plants. Trials were run in duplicate. Cultures were renewed every three days, noting the amount of solution absorbed by the plants.

For the check, Espino's (1920) best four-salt solution type A consisting of one part KH_2PO_4; 1½ parts $(NH_4)_2SO_4$; 1½ parts $Ca(NO_3)_2$ and 4 parts $MgSO_4$, the concentration of which was 0.002 gram-molecule (of all the salts taken together) per liter, was used.

The results obtained are summarized by the author as follows:

1. When grown in single salt solutions young rice plants suffered physical injuries which varied with concentrations and the different salts. The higher the concentration the greater was the injury by the plants or *vice-versa.*

2. Of the nitrates, KNO_3 and $Mg(NO_3)_2$ were the most harmful; NH_4NO_3 and $Ca(NO_3)_2$ seemed beneficial to the young rice plants.

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[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

[2] To simplify discussion ammonium (NH_4) is considered in this paper as a metal.

3. The sulfates were, as a whole, the least toxic and the most nutritious to young rice plant. K_2SO_4 was the best.

4. Of the phosphates, KH_2PO_4 was the best in producing well developed plants. The $Ca(H_2PO_4)_2$ was the most harmful.

5. Of the chlorides, NH_4Cl was the most beneficial. Other chlorides were similar in effect. The plants had leaves pointing upward.

6. Except $CaCO_3$, the other carbonates were harmful to the young rice plants, particularly the $(NH_4)_2CO_3$ and the K_2CO_3.

7. KNO_3, $Mg(NO_3)_2$, $Ca(H_2PO_4)_2$ and $(NH_4)_2CO_3$ were the most toxic, especially in the higher concentrations.

8. Of the different solutions, the potassium salt solutions, were highly absorbed by the young rice plants, especially at lower concentrations.

9. Plants grown in potassium salt solutions were heavier in dry weight than in any other solution.

10. Plants grown in potassium salt solutions were likewise the tallest.

—*Abstract by L. N. Talatala.*

EXCHANGE NOTES

Tenancy is one of the most important problems in the world. Most of the agricultural economists disapprove of the system of tenancy, pronouncing it the vice of agriculture. For countries in which labor is scarce, the attack on tenancy is always great, because these countries have plenty of capital and land, and tenancy is, therefore, not justified. The condition of agriculture in China is different. The most urgent need of Chinese agriculture is capital, and land which is a form of capital. There are many men who can work on the farm, but there is lack of capital. Some one must provide capital and land for them. Therefore tenancy is a matter of circumstances in China. It is a form of coöperation between the city people and the rural people, between the poor and the rich. So far as it is just to both sides, it is a good system. It is a sort of mutual help which exists because of natural consequences. So far as the Honan Island [on which Lingnan University is situated] villages are concerned, we have never found a case of disagreement between the tenant and the owner, in spite of the high percentage of tenancy on the Island.

Among all the farm workers of the Island, 79 per cent are tenants, 16 per cent are partial owners, and only 5 per cent are owners. . . .

Altho the percentage of tenancy on the Island is high, dealings between the tenant and owners are very just and harmonious. Dissatisfaction is seldom heard from either side. The rate of rent varies with the region, but it averages from seven to twelve per cent of the market value of the land. . . .

—*Lingnan Science Journal* (China), August, 1931.

Locusts, which have caused extensive damage in East Africa, are reported to have destroyed 10,000 acres of sugar cane in the Miwani district of Kenya.

The Hawaiian sugar crop for 1931 was estimated at the beginning of June at 854,000 long tons.

It is claimed that the cost of producing sugar in Java has been definitely reduced through the introduction of P. O. J. 2878.

—*The Australian Sugar Journal*, September 3, 1931.

Few fruits, if any, have in India the reputation and history of the Mango (*Mangifera indica*) considered by De Candolle to have been in cultivation for many centuries, and certainly as far back as any dependable records go.

A native of India and the eastern tropics, its cultivation reaches to all tropical regions of the world, but the true home of the mango with its numerous varieties and hybrids is undoubtedly India.

Sturtevant in his "Notes on Edible Plants" gives Tropical Eastern Asia as the home of *Mangifera indica* and regarding the distribution of this fruit he records that the mango was introduced to Jamaica in 1782. In 1880 several fruitful and superior varieties were growing in the Botanic Gardens in Trinidad, and at Cayenne it was introduced at the beginning of the present century. Its introduction into Brazil was more ancient as the seeds came thence from Barbadoes in the middle of the eighteenth century, and in Martinique, by grafting, a dozen distinct varieties of excellent quality have been established. In Mauritius a number of varieties are established, whilst the tree is now grown to a limited extent in Florida also.

—*The Tropical Agriculturist* (Ceylon), April, 1931.

Boiling mercury will take the place of electric motors and pumps in home refrigerators if a new method just announced comes into general use. The new process is the invention of Dr. Daniel F. Comstock, president of Comstock and West, and Lyman F. Whitney, of the firm's technical staff. Dr. Comstock was a former member of the faculty of Massachusets Institute of Technology and was one of the inventors of the technicolor process of motion pictures in color. The machine is called a stator, because all moving machinery has been eliminated. Instead a small boiler contains mercury, and when it is heated and the mercury boils, the vapor is discharged into a venturi tube, sucking water vapor from the cooling unit and compressing it. Under the reduced pressure the remaining water rapidly evaporates, with resultant cooling. The heavy mercury flows back into the boiler and as it does so it pumps the water from the condensed water vapor back to its original height.

—*Science.*

Besides being one of the hardiest of the known agricultural crops for hot, dry conditions, Lucerne is one of the most palatable and nutritious foods for livestock, and all of the farm animals and birds maintain themselves and thrive on it. The crop has been cultivated for centuries in the semi-arid portions of Asia, as well as in parts of Europe, and in all places it produces an abundance of fodder of the highest quality, improves poor soils, and eradicates weeds. . . .

Lucerne is one of the very old agricultural plants, having been domesticated for thousands of years, and in man's rise in civilisation it has played an important part, and has been established by man in almost all parts of the earth. It spread from central Asia into Greece and Italy, then throughout the Mediterranean region and into northern Europe. The Spaniards took it to South America, from where it spread into North America, and the crop has done so well in the Americas, and so much publicity has been given to it by the United States that there are at present very few places in the World where it is not known.

In Europe the plant was called Lucerne, under which name it is still known in Australia, but the Americans use the Spanish name of Alfalfa, which was derived from the Arabic name meaning "the best kind of fodder."

—*The Journal of the Department of Agriculture* (South Australia), April 15, 1931.

COLLEGE AND ALUMNI NOTES

Hon. José Sanvictores addressed the Student's Convocation on October 24 on "Economic Leadership". Mr. Sanvictores, now manager of a cattle ranch in Bukidnon, has the distinction of being the first Filipino to be graduated from a College of Agriculture. His Alma Mater is the University of Illinois. With this background and his experience a practical talk was to be expected and Mr. Sanvictores did not disappoint the audience. His address was sensible and sane. He kept his feet squarely on the ground.

Dean Gonzalez received in November a very cordial letter from Hon. Theodore Roosevelt, Governor of Porto Rico, inviting this College to send a delegation of sugar technologists to the Fourth Triennial Conference of the International Society of Sugar Cane Technologists which will be held at San Juan, Porto Rico, from March 1 to 16, 1932. Governor Roosevelt as Honorary President of the Fourth Conference of this society issues the invitation and assures the delegation a hearty welcome.

Dean Gonzalez indorsed Governor Roosevelt's letter to President Palma presenting the great benefit to the College and Philippine sugar industry that would accrue from sending a delegation or at least a delegate to this congress.

Tropical Life, September, 1931, quotes from and comments on the article by Dr. F. L. Stevens on "New or Noteworthy Philippine Fungi" which appeared in July number of THE PHILIPPINE AGRICULTURIST.

Mr. José M. Capinpin, B.Agr. '20, B.S.Agr. '22, M. S. Agr. '23, a government pensionado, accompanied by Mrs. Capinpin returned recently from the United States *via* Europe and is now employed as Instructor in the Department of Agronomy of the College of Agriculture. Doctor Capinpin obtained his Ph. D. degree from Princeton University, Princeton, New Jersey, U. S. A. He majored in genetics and cytology under Professor G. H. Shull and Professor E. G. Conklin, carrying as minors, experimental morphology and physiology. Doctor Capinpin is the first Filipino recipient of a doctorate degree from the pure science department of Princeton University. At present, he is helping Doctor Mendiola in carrying out an important program of plant improvement work including the breeding of sugar cane. Some of the important problems assigned to Doctor Capinpin include the determination of the number of chromosomes of important sugar cane varieties used in local hybridization work; cytogenetical analysis of inter- and intra-specific hybrids of pineapples; and investigations on problems of sterility and fertility of some major Philippine crop plants.

Dr. L. B. Uichanco was the guest of honor on the Science Program on October 30 at the Batangas High School, where he delivered a convocation address.

Doctors D. V. Villadolid and Francisco M. Sacay and Mr. S. Reantaso visited the biology laboratory of the Batangas High School on October 30, for the purpose of getting ideas as to how laboratories of this kind are conducted in the provincial schools.

The Los Baños Biological Club met on Thursday, October 29, 1931, at 7:30 p. m., in the Lecture Hall of the Department of Agricultural Chemistry of the College of Agriculture, Los Baños, Laguna.

The following papers were read and discussed:

"Propagation of narra (*Pterocarpus indicus* Willd.) by cuttings". —By Mr. Porfirio San Buenaventura.

"An improved device for adding the saturated alkali solution in the Kjeldahl method for nitrogen determination".—By Dr. F. T. Adriano.

Mr. Anselmo Labrador, B.Agr. '20 for some time an employé of the Bureau of Plant Industry, at La Carlota Sugar Cane Experiment Station, died at his home in Zambales in October.

Among recent Campus visitors was Mr. Basilio A. Viado, B.Agr. '22, B. S. Agr. '29. Mr. Viado is now Principal of Indang Rural High School, Cavite. On his staff are Mr. Cesario Bandong, B. Agr. '29, Mr. Miguel Ocampo, B. S. A. '30, and Mr. Francisco Pañganiban, B. Agr. '24, and Mr. Nicanor del Rosario, former student in College of Agriculture.

Mr. Valeriano Calma, B. S. A. '28, was a recent Campus visitor. Mr. Calma is just back from the United States where he had been studying. He was at Audubon, Louisiana, for special work on sugar. In June, 1931 he received degree of Ph. D. from Iowa State College. Doctor Calma returned home by way of Europe. He is now employed in Bureau of Plant Industry.

A letter from Antonio Pedroso, B.Agr. '31 to Professor Yule, gives a graphic description of pioneer farming work in Balingasay, Or. Misamis. "I am in the middle of the jungle of Balingasay, isolated from society, but have my dogs and one companion. We have cleared about four hectares and planted corn and vegetables". Mr. Pedroso told of the many coffee and cacao seedlings ready for transplanting. He also told of the noise of the flying lemur and the call of the deer at night, and of killing a six-meter python. Wild fruit and honey are brought to him by the pagans from the hills. For meat, he kills deer, wild hogs, and monkeys. Mr. Pedroso is teaching some of the hill pagans to read and write, tuition paid in labor. He also finds his barber training advantageous. "For one hair cut, a mountaineer will work one-half day felling trees".

Mr. Ramon A. Cruz, B. S. A. '23, Instructor in Agricultural Chemistry, was married October 29, 1931, at Tanza, Cavite, to Miss Julita Jansuy of the same town. Miss Jansuy was graduated from the Philippine Dental College in 1929.

The report on registration, from office of Secretary, College of Agriculture for second semester:

Freshmen	105
Sophomores	149
Juniors	186
Seniors	115
Special Graduate Students	2
Candidates for certificate in Agricultural Education	5
Special Students	8
College of Agriculture students	570
Cross Registrants from:	
College of Veterinary Science	72
School of Forestry	4
U. P. Rural High School	9
All Students	655
New students enrolled	4

Graduation of the following students was recommended by the Faculty of the College of Agriculture in meeting held on October 21, 1931:

(*a*) *Bachelor of Science in Agriculture:*
- (1) Dixon, Marcelo J.
- (2) Gesmundo, Artemio G., B. Agr. '30.
- (3) Isidoro, Francisco.
- (4) Javier, Vedasto.
- (5) Luna, José F.
- (6) Magsino, Juan R., B. Agr. '22.
- (7) Reantaso, Sisenando, B. Agr. '28.
- (8) Reynes, Cosme O.
- (9) Maranion, Estanislao T.

(*b*) *Bachelor of Agriculture:*
- (1) Barsana, José G.
- (2) Caguicla, Elena M. (Miss)
- (3) Cero, Magdaleno M.
- (4) Fajardo, Abelardo J.
- (5) Guzman, Jesus de
- (6) Mercado, Ramón T.
- (7) Tugade, Domingo
- (8) Villegas, Leonisa J. (Miss)

SCIENCE AND PRODUCTION

It is generally assumed that today we are living in an age of overproduction of almost everything. It is a condition of affairs that does not lend itself to elucidation very readily. Is it that in the past we have been more in a position of equilibrium between consumption and production? If so, what are the disturbing forces that have recently come into play to upset our continuing in that state in which we found ourselves? Is it that the population of the earth has suddenly decreased but been left with a surfeit of previously produced or provided-for material—rubber or coconut trees, prairies turned into smiling fields of corn, accumulation of textiles, and machines with which to make them? No; generally it does not seem so, although there may be a halt in the birth rate of some countries the advance in others is too stupendous to allow of any explanation at the rate of two and a half millions a year and China even faster. The tendency in Asia generally is for an enormous increase of human beings.

Malthus and Darwin both put forward the views that there was a tendency for population to increase beyond the bounds of subsistence but as great as is the increase that state of affairs seems now to be reversed and production to have increased beyond the pace of human reproduction.

To what then must we look for this seemingly never-ending increase of the wants of man at a pace for outstripping his own multiplication? This pace is the primary reason for the lowness in price of our rubber, coconuts, tea, and rice, to say nothing of the other man's commodities. The explanation is in very large part to be found in the development of modern science.

Crookes in 1898 called attention to the then low yield of the world's cereals and predicted starvation conditions within a measurable time owing to the rapidly increasing population unless the chemist could come to the aid of the cereal grower and provide him with a cheap and unlimited supply of nitrogen. The cheap supply of nitrogen is today the triumph of the chemist, it is an accomplished fact, he has harnessed the nitrogen of the air for the use of the earth. The engineer has given us mechanisation beyond the dreams of even our fathers. Land within the last half century required for the support of our beasts of burden and draught is now free for food production and is ploughed by the very mechanisation that has set it free. Not only has science made our land yield more individual plants per acre but she has gone further still and made the very plants themselves to mul-

THE PHILIPPINE AGRICULTURIST, VOL. XX, NO. 9, FEBRUARY, 1932.

tiply their produce. The plant breeder with increasing knowledge of that wonderful phenomenon called heredity has given us races of crops, the quantity and quality of whose products have far outstripped those of their ancestors. The foes of our field crops have been overcome by the studies of the entomologist who has often turned upon them methods of destruction previously peculiarly their own.

These are but the aspects of science applied to agriculture, that is production from the soil. Science applied to our manufacturing processes for the further elaboration of the primary products has achieved results by no means less startling. Our complaints of low prices would almost seem to be the penalty of science applied to human progress.

As Sir Harry McGowan recently put it when presiding at the Society of Chemical Industry—"The balance between industrial and agricultural production had been dislocated. The scientist might congratulate himself upon having made two canes of sugar grow where only one grew before but the industrialist might see his financial structure tumbling about his ears. Every improvement in processes which increased mastery over Nature tended to lead to increased supply. The vast number of workers in industry were slow to realize that their products were bringing in less money, and therefore, slow to grasp that unless all costs fell proportionately with prices business would be lost and employment reduced".

—*The Tropical Agriculturist*, September, 1931.

For my part I would oppose the graduation of any student from this university who had not added to his command of correct English a habit of clear and distinct articulation. To say words in a slovenly manner is, to my mind, a much worse defect than poor spelling.—R. H. WALKER, *Ohio Wesleyan University.*

—*What the Colleges are Doing.*

OBSERVATIONS ON THE ACTIVITY OF PHILIPPINE CARABAOS IN THE BARN[1]

VALENTE VILLEGAS AND A. T. TALEON
Of the Department of Animal Husbandry

A close approach to rational management of animals is possible only after gaining an intimate knowledge of their habits. With this principle in mind this work was undertaken to secure additional information on the habits of Philippine carabaos.

Specifically, the objects of this study were to determine the activities of Philippine carabaos under barn conditions during a period of 24 hours in respect to feeding, rumination, lying down position, defecation and urination.

The study was carried on in the College of Agriculture, University of the Philippines, on March 14, 17, 18, 19, 1930 and from April 29 to May 10, 1931, covering altogether a period of 16 days.

ANIMALS

In all, seven native carabaos were used, one steer and six cows. One female, No. 9, was in advanced pregnancy. The animals ranged in weight from 416 to 511 kgm., the average being 473 kgm. Nos. 45 and 54, the youngest, were four and five years old and Nos. 1 and 4, the oldest, were 19 and 20 years, respectively; the average of the seven was 10.4 years.

FEEDS AND BARN

For feeding the animals sugar cane tops and fresh corn forage were used in 1930, and corn silage in 1931. They were given at each feeding time all that they would consume. Water and salt were also furnished as part of the feeding operation.

A barn of concrete floor was used rendering the place sanitary and the collection of feces possible. The animals were kept in individual stalls provided with stanchions during the day. At night they were transferred to an open space where they were free to move about as they pleased.

MANAGEMENT

At about six o'clock in the morning the animals were placed in separate stanchions, and bathed. Shortly before seven o'clock they were fed, then

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[1] Experiment Station contribution No. 775. Read before the Los Baños Biological Club on December 22, 1931. Received for publication December 23, 1931.

The writers are indebted to Messrs. Eugenio Agudo, Manuel Tuya and Sotero Penuliar for invaluable assistance faithfully given during the progress of the investigation.

watered immediately after they finished eating. Salt was given them soon after watering. They were again fed, watered and salted at about 11:00 a. m. and 4:00 p. m. At about 6:00 p. m. the animals were taken out of the stalls and placed in the open where they remained till the next morning.

The weight of each animal was taken at the beginning and close of the work to find out if any loss of flesh incident to feeding and management had taken place. The general health of the animals was observed throughout the study.

METHOD OF OBSERVATION

From the beginning to the close of both 1930 and 1931 periods of observation, a constant watch on the activities of the animals was kept. In other words, arrangement was made so that an observer was always on duty during the 24 hours of the day during the investigation. Tabulated forms were provided on which any activity of the animals was duly recorded at the time of occurrence. The amount of feces and urine passed out was determined and recorded soon after collection.

To insure prompt collection of the feces, clean empty cans and shovels were kept near the animals. In some cases, it was possible to get the feces directly from the animals by holding the cans behind them in the act of defecation. The collection of urine was invariably done by holding the can near the animals at the time of urination. It was not until the time of urination and the peculiarities of the animals were determined that successful collection of urine was made. Certain carabaos in the experiment were found to be so sensitive that they would hold part of the urine while the can was being placed near them until after they had become used to the practice. For these reasons, the collections of urine were few and incomplete for the day.

For rumination, lying down position and urination, Nos. 1, 4, 9 were under observation for four days each; Nos. 30 and 39, for thirteen days each; and Nos. 45 and 54, for nine days each. Observation for defecation covered a period of 3 days with No. 4; 4 days with each of Nos. 1 and 9; 12 days with each of Nos. 45 and 54; 14 days with No. 39; and 16 days with No. 30.

RESULTS AND DISCUSSION

Feed consumption

The data presented on feeding refers only to corn silage for which the time of consumption was recorded. Table 1 shows that the amount of silage eaten by each animal ranged from 20.7 to 26.2 kgm., the average being 24.1 kgm., daily. That is, for every 100 kgm. live weight of the animals the consumption was 5.1 kgm. It took the animals from 4.1 to 4.9 minutes or an average of 4.3 minutes to consume one kgm. of silage. Incidently, No. 54 which consumed the smallest amount fed the most slowly and No. 39 which consumed the largest amount was one of the fastest feeders.

Villegas (1930) found that native carabaos consumed an average of 33.8 kgm. of fresh sugar cane tops and corn forage per head daily, which is equivalent to 7 kgm. of forage for every 100 kgm. of the animal's live weight.

Rumination

Table 3 shows that the native carabaos ruminated from 16.5 to 20.6 times during the day, averaging 19.2 rumination periods. On the average, the animals chewed their cud from 19.8 to 27.7 minutes, or an average each time of 22.2 minutes for all carabaos. The total time spent by each animal in rumination daily varied from 6 hours, 8.5 minutes to 7 hours, 46 minutes, or an average of 7 hours, 7.5 minutes. Belz (1910) found that cattle, sheep and goats ruminate from four to six times a day, the period of rumination being on an average of 25 to 35 minutes each time. Smith (1916) states that out of twenty-four hours, seven is passed in rumination.

In table 2 it is shown that 65.38 per cent of the cud-chewing took place from 6:00 p. m. to 5:00 a. m., or from after the afternoon feeding to just before the day's activities started. It will be observed that rumination took place at every hour interval during the night, the longest period being between eight and nine o'clock. From 6:00 a. m. to 8:00 a. m. and 4:00 p. m. to 5:00 p. m. rumination time was at the lowest. The frequency of rumination each hour throughout the night was greater than during the daytime except from 9:00 to 11:00 a. m. and between 1:00 and 3:00 p. m. It is, therefore, apparent that native carabaos should be left to themselves at night to give them ample time to chew their cud, especially with animals that are heavily worked during the day.

As may be seen in table 4, native carabaos started rumination after feeding on an average of 1 hour, 47.3 minutes in the morning, 1 hour, 9.9 minutes at noon, and 1 hour, 52.3 minutes in the afternoon. The average time after the three feeding periods before rumination was 1 hour, 36.5 minutes.

Belz (1910), observing grown cattle, calves, sheep and goats, found that rumination started from 45 minutes to 1 hour and fifteen minutes after feeding.

Defecation

Table 5 shows that native carabaos defecated from 2.0 to 4.1 times, or an average of 3.4 times, during 24 hours. The amount of feces voided each day ranged from 14.6 to 19.2 kgm., or an average of 16.6 kgm. The lowest average amount of feces voided each time was 3.9 kgm. and the highest was 7.8 kgm., the average for all animals being 4.9 kgm. It was evident that the more frequent the animals defecated the less the quantity voided at each time. Basing calculations on the average weight of feces voided each day, the ratio between the weight of feces to the weight of the animals was 3.5 kgm. of feces for every 100 kgm. live weight of the animal.

Table 2 shows that the animals defecated most from 5:00 to 6:00 a. m. when 17.90 per cent of the total defecation took place. The second period of greatest defecation was between 4:00 and 5:00 p. m. with 10.48 per cent. The first hour period coincided with sunrise after the night's rest and the second hour period coincided with the last feeding period before the animals were taken from the stalls to the open area. It is worthy of consideration that throughout the whole period of observation all the animals did not defecate between eight and ten o'clock in the morning.

Urination

It may be seen in table 6 that native carabaos urinated on an average of from 1.8 to 9.3 times, averaging 3.0 times. a day. An unusual case was No. 1, an old cow, which urinated on an average of 9.3 times daily. Excluding her record, the average for the animals was 2.5 times a day.

From data in table 2 it is evident that there was not an hour throughout the investigation that some of the animals did not urinate, although from 8:00 to 9:00 p. m. and from 1:00 to 5:00 a. m. the frequency of urination was insignificant or less than at any other time during 24 hours. From 5:00 to 7:00 a. m., 38.09 per cent of the total number of urinations took place, the highest percentage within two hours during 24 hours. From 1:00 to 5:00 p. m. as much as 32.1 per cent of the number of urinations occurred. During the first two hours the animals have just roused from their night's rest while during the latter four hours their day activities were ending. It may also be noted that a large percentage of defecations and urinations took place simultaneously between five and six o'clock in the morning and four and five o'clock in the afternoon. It is likewise significant that from 8:00 to 10:00 a. m., when there was no defecation, the frequency of urination was also low, and between 1:00 and 5:00 a. m., when the percentage of urinations was lowest the number of voidings was few.

Out of the 15 samples of urine collected, the volume ranged from an average of 2,437.5 to 6,483.3 cc. from each urination, the average for all animals being 4,865.0 cc. Number 30, the only male animal in the experiment, urinated the least. The ratio of the volume of urine per urination to the weight of the animals was 1,037.3 cc. for every 100 kgm. live weight. Inasmuch as on the average the animals urinated 3 times a day, the volume of urine voided per day for every 100 kgm. live weight was approximately 3,111 cc.

Lying down position

Table 7 shows that native carabaos lay down as frequently as from an average of 5.3 to 11.4 times during the day, or an average of 10.1 times for all the animals. The aggregate time spent in lying down position by each animal amounted to an average of from 7 hours, 2 minutes to 9 hours, 5 minutes daily, or an average of 8 hours, 11.9 minutes for all. The animals spent an average of 48.7 minutes lying down each time, the variation being from 40 minutes to 1 hour, 23.9 minutes.

As may be seen in table 2, the animals were in lying down position more at night than during the day, 72.6 per cent of time spent in this position being from 6:00 p. m. to 5:00 a. m. More of the time or 10.95 per cent, was spent in this position between 6:00 and 7:00 p. m. than at any other hour during the 24 hours. The hours when the animals were almost always in standing position were from 5:00 to 8:00 a. m. and from 3:00 to 5:00 p. m.

The results point out that most of the time spent in rumination was when the animals were in lying down position. That is, rumination which took place to the extent of 65.38 per cent from 6:00 p. m. to 4:00 a. m. coincided with 72.6 per cent of lying down position observed during the same period. On the other hand, between 6:00 and 8:00 a. m. and between 4:00 and 5:00 p. m. when the animals ruminated the least, it will be noted that they were then in standing position. It may, therefore, be stated that among native carabaos a lying down position appears to afford a most favorable condition for rumination.

SUMMARY

Observations on the activities of Philippine carabaos in the barn revealed the following results:

1. Native carabaos consumed on an average 24.1 kgm. of corn silage per head daily, this being equivalent to 5.1 kgm. of the feed for every 100 kgm. live weight. The average duration of feeding was 4.3 minutes for each kilogram of corn silage.

2. On an average, the native carabaos ruminated as much as 19.2 times, covering a total period of 7 hours, 7.5 minutes, during 24 hours. The average time spent in each rumination period was 22.2 minutes. The average period after feeding time before the animals started to chew their cud was 1 hour, 36.5 minutes.

3. The average amount of feces voided by native carabaos was 16.6 kgm. per head daily, which is equivalent to an average of 3.4 kgm. for every 100 kgm. of their live weight. Each carabao was observed to defecate on an average of 3.4 times during 24 hours.

4. Defecation took place most frequently between 5:00 and 6:00 a. m. and between 4:00 and 5:00 p. m.; between 8:00 and 10:00 a. m. no feces was voided.

5. Urination took place on an average of three times during 24 hours; the average amount of urine passed out each time was 4,865.0 cc.

6. Native carabaos urinated more frequently between 5:00 and 7:00 a. m. than at any other two-hour period in 24 hours. Much urine was also

passed between 1:00 and 5:00 p. m. Urination took place the least frequently between 8:00 and 9:00 p. m. and between 1:00 and 5:00 a. m. The large percentage of defecation occurring between five and six o'clock in the morning was accompanied by a large amount of urine passed within the same period. In like manner, between 8:00 and 10:00 a. m. when defecation was nil and between 1:00 and 5:00 a. m. when only a few voidings were observed, urination was low.

7. On an average the animals lay down as often as 10.1 times during 24 hours; the average time spent in lying down position during the same period was 8 hours, 11.9 minutes. The average length of each lying down period was 48.7 minutes.

8. Rumination and lying down position were observed to occur simultaneously, especially during the night. The animals scarcely ruminated at all between 6:00 and 8:00 a. m. and between 4:00 and 5:00 p. m., periods during which they were always in standing position. However, it appears that native carabaos find conditions most favorable for rumination when in lying down position.

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TABLE 1

Showing silage consumption and duration of feeding per head daily

DATE	HERD NO. 30			HERD NO. 39			HERD NO. 45			HERD NO. 54		
	Amount consumed	Duration of feeding	Time to consume 1 kgm. feed	Amount consumed	Duration of feeding	Time to consume 1 kgm. feed	Amount consumed	Duration of feeding	Time to consume 1 kgm. feed	Amount consumed	Duration of feeding	Time to consume 1 kgm. feed
1931	*kgm.*	*hr. min.*	*min.*	*kgm.*	*hr. min.*	*min.*	*kgm.*	*hr. min.*	*min.*	*kgm.*	*hr. min.*	*min.*
May 2	26.6	2 : 4	4.7	27.8	2 : 7	4.6	24.8	2 : 6	5.1	24.6	2 : 19	5.7
May 3	20.1	1 : 27	4.3	21.9	1 : 38	4.5	21.2	1 : 38	4.6	17.4	1 : 43	5.9
May 4	21.6	1 : 31	4.2	22.4	1 : 22	3.7	20.4	1 : 22	4.0	18.0	1 : 25	4.7
May 5	26.8	1 : 54	4.3	27.8	1 : 54	4.1	23.2	1 : 38	4.2	18.8	1 : 34	5.0
May 6	25.2	1 : 35	3.8	27.6	1 : 51	4.0	24.4	1 : 31	3.7	19.6	1 : 35	4.8
May 7	23.4	1 : 29	3.8	24.2	1 : 25	3.5	24.9	1 : 25	3.4	19.4	1 : 26	4.4
May 8	29.0	1 : 39	3.4	28.3	1 : 42	3.6	28.3	1 : 32	3.3	24.5	1 : 52	4.6
May 9	33.4	2 : 5	3.7	29.4	2 : 3	4.2	28.2	2 : 3	4.4	22.8	1 : 16	3.3
May 10	27.6	1 : 51	4.0	26.4	1 : 56	4.4	27.0	1 : 59	4.4	21.4	2 : 15	6.3
Average	24.9	1 : 35	4.2	26.2	1 : 46	4.1	24.7	1 : 42	4.1	20.7	1 : 43	4.9

TABLE 2

Showing time distribution of rumination, defecation, urination and lying down position during 24 hours for all animals for the whole period of observation

TIME	RUMINATION		DEFECATION		URINATION		LYING DOWN POSITION	
	number	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
6:01— 7:00 a. m.	1	.09	9	3.93	27	16.07	——	——
7:01— 8:00 a. m.	3	.28	5	2.18	2	1.19	——	——
8:01— 9:00 a. m.	16	1.49	——	——	2	1.19	15	2.65
9:01—10:00 a. m.	58	5.39	——	——	3	1.79	28	4.95
10:01—11:00 a. m.	49	4.55	3	1.31	3	1.79	19	3.36
11:01—12:00 a. m.	13	1.21	6	2.62	4	2.38	21	3.71
12:01— 1:00 p. m.	41	3.81	11	4.80	2	1.19	20	3.53
1:01— 2:00 p. m.	68	6.31	8	3.49	8	4.76	21	3.71
2:01— 3:00 p. m.	45	4.18	15	6.55	10	5.95	8	1.41
3:01— 4:00 p. m.	27	2.51	13	5.68	19	11.31	1	.18
4:01— 5:00 p. m.	3	.28	24	10.48	17	10.12	——	——
5:01— 6:00 p. m.	31	2.88	7	3.06	6	3.57	21	3.71
6:01— 7:00 p. m.	59	5.48	14	6.11	6	3.57	62	10.95
7:01— 8:00 p. m.	58	5.39	11	4.80	3	1.79	45	7.95
8:01— 9:00 p. m.	80	7.43	7	3.06	1	.59	41	7.24
9:01—10:00 p. m.	72	6.69	3	1.31	3	1.79	45	7.95
10:01—11:00 p. m.	62	5.76	10	4.37	4	2.38	27	4.77
11:01—12:00 p. m.	72	6.69	6	2.62	5	2.98	41	7.24
12:01— 1:00 a. m.	67	6.22	14	6.11	2	1.19	37	6.54
1:01— 2:00 a. m.	67	6.22	4	1.75	1	.59	32	5.65
2:01— 3:00 a. m.	65	6.03	9	3.93	1	.59	33	5.83
3:01— 4:00 a. m.	57	5.29	3	1.31	1	.59	26	4.59
4:01— 5:00 a. m.	45	4.18	6	2.62	1	.59	22	3.89
5:01— 6:00 a. m.	18	1.67	41	17.90	37	22.02	1	.18
Total	1077	100.03	229	99.99	168	99.99	566	99.99

TABLE 3

Showing frequency and period of rumination

HERD NO.	FREQUENCY OF RUMINATION		RUMINATION PERIOD	
	Total	Av. a day	Av. a day	Av. per rumination
			hr. min.	*min.*
1	66	16.5	7 : 37.0	27.7
4	68	17.0	6 : 8.5	21.7
9	77	19.3	7 : 46.0	24.2
30	268	20.6	7 : 35.3	22.1
39	254	19.5	7 : 8.3	21.9
45	171	19.0	7 : 8.8	22.6
54	173	19.2	6 : 21.0	19.8
Average		19.2	7 : 7.5	22.2

TABLE 4

Showing the time from end of feeding period to first rumination

FEEDING TIME	HERD NO. 30	HERD NO. 39	HERD NO. 45	HERD NO. 54	AVERAGE
	hr. min.	*hr. min.*	*hr. min.*	*hr. min.*	*hr. min.*
Morning	1 : 44.2	2 : 15.7	1 : 13.0	1 : 56.3	1 : 47.3
Noon	1 : 16.4	1 : 4.3	1 : 11.9	1 : 6.9	1 : 9.9
Afternoon	1 : 36.2	1 : 39.1	1 : 51.9	2 : 22.1	1 : 52.3

TABLE 5

Showing the frequency of defecation and amount of feces voided

HERD NO.	NUMBER OF DEFECATION		AMOUNT OF FECES VOIDED	
	Total	Av. each day	Av. each day	Av. at each defecation
			kgm.	*kgm.*
1	8	2.0	15.5	7.8
4	10	3.3	17.9	5.4
9	12	3.0	14.6	4.9
30	65	4.1	16.4	4.0
39	45	3.2	19.2	6.0
45	38	3.2	17.5	5.5
54	45	3.7	14.7	3.9
Average.		3.4	16.6	4.9

TABLE 6

Showing the frequency of urination and the volume of urine passed

HERD NO.	FREQUENCY OF URINATION		VOLUME PASSED	
	Total	Av. each day	Number of samples collected	Av. per urination
				cc.
1	37	9.3	—	—
4	11	2.7	—	—
9	15	3.8	—	—
30	41	3.2	4	2,437.5
39	24	1.8	5	5,790.0
45	20	2.2	3	6,483.3
54	20	2.2	3	4,941.7
Average.		3.0		4,865.0

TABLE 7

Showing the frequency and time spent in lying down position

HERD NO.	FREQUENCY ANIMAL LAY DOWN		TIME SPENT IN LYING DOWN POSITION	
	Total	Av. each day	Av. each day	Av. of each period
			hr. min.	*hr. min.*
1	31	7.7	8 : 49.3	1 : 8.3
4	21	5.3	7 : 20.8	1 : 23.9
9	44	11.0	9 : 5.0	49.5
30	142	10.9	8 : 25.4	46.3
39	130	10.0	8 : 2.0	48.2
45	103	11.4	8 : 58.7	41.1
54	95	10.6	7 : 2.0	40.0
Average. .		10.1	8 : 11.9	48.7

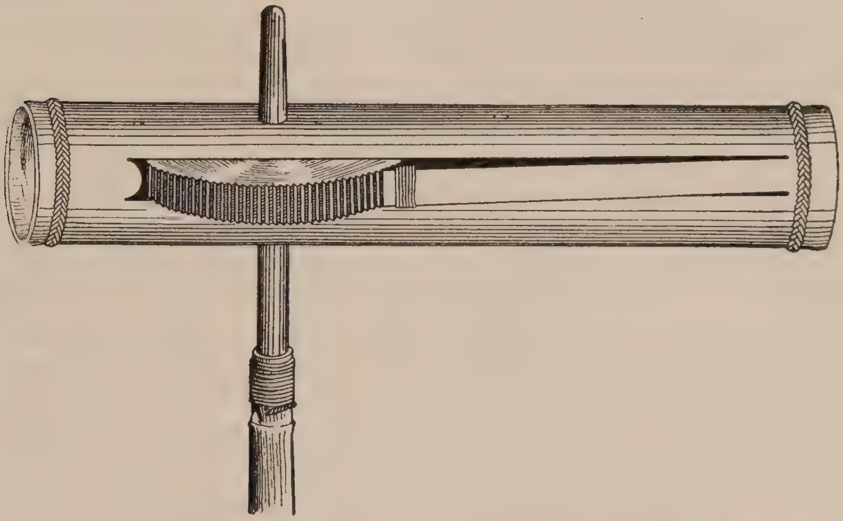
METHODS AND GEAR USED IN FISHING IN LAKE TAAL AND THE PANSIPIT RIVER[1]

DEOGRACIAS V. VILLADOLID
Of the Department of Entomology

WITH FOUR PLATES AND THREE TEXT FIGURES

In connection with the investigation of the fisheries of Lake Taal and Pansipit River[2], the writer was able to make first hand observations on the fishing gear and methods of fishing used in the regions covered by the survey.

First and most important of the fishing methods followed in the waters within the boundaries of the municipalities of Taal and Lemery is the *baklad*, or fish corral. Quite a large amount of capital has been invested in the *baklad* industry. A single corral costs from five hundred to several thousand pesos. So much bamboo is used in the construction of the *baklad* that the supply is fast becoming depleted in the neighborhood of Lake Taal.



Text fig. 1.—*Balakatak*, a device used to produce noise to help drive the fish towards the *baklad Pansipit*.

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[1] Report No. 2, on an investigation trip in April, 1931, for the purpose of studying the fisheries of Lake Taal and the Pansipit River, Batangas Province.

Experiment Station contribution No. 776. Received for publication August 28, 1931.

[2] See Villadolid, Deogracias V. 1931. A preliminary study of the larval fishes found in the mouth of the Pansipit River and in Balayan, Nasugbu and Batangas bays. The Philippine Agriculturist **20**: 511-516.

Baklad Pansipit. (Pl. III, fig. 4.) This is a huge fish corral constructed in the Pansipit River about a kilometer from the source of the stream, or where it flows from the lake. The width of the corral is the same as that of the river, so that all the fish with the exception of very small ones that can pass through the narrow openings of the weir are caught in its compartments. Spawning fish and those that make the annual seaward migrations from Lake Taal are trapped in the *baklad Pansipit.*

To insure an almost continuous supply of fresh fish for the market, the migrating fish are from time to time driven into the *baklad Pansipit.* This is accomplished as follows: A guard house is maintained at some advantageous point in the Pansipit River near its source in the lake where the schools of fish migrating seaward can be detected. As soon as the fish enter the stream from the lake the guards rush to the scene and drive the fish towards the *baklad* by making a loud noise with a bamboo *balakatak* (Text fig. 1) and at the same time they stretch a seine across the stream to prevent the fish getting back into the lake. As soon as the fish are driven into that portion of the river where a *baklad* fence is set, the gate is closed, thus the fish are corraled in the *baklad Pansipit.*

Seventeen laborers are assigned to repair and take care of the *baklad Pansipit.* These laborers are paid on the basis of one-eleventh of the total catch, thus for every ₱11,000 worth of fish that are caught in the *baklad Pansipit,* the laborers receive ₱1,000.

Baklad bukana. (Pl. II, fig. 2). The *baklad bukana* are a series of fish corrals set along the shores of Lake Taal bordering the source of the Pansipit River, or its junction with the lake. Fish from Lake Taal on their seaward migrations are caught in these *baklad.* These fish corrals are constructed by fishermen using materials furnished by the company holding the franchise, and for their labor and trouble in caring for and repairing the corrals and catching the fish, they receive one-sixth of the total catch.

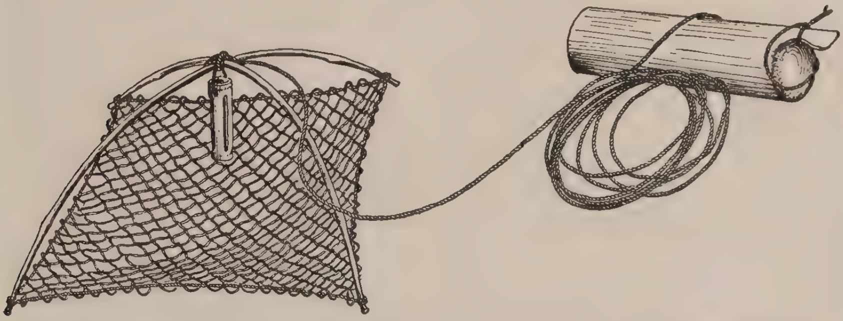
Baklad wawa. The *baklad wawa* is a series of fish corrals constructed along the shores of Balayan Bay near the mouth of the Pansipit River and within the boundaries of the municipalities of Taal and Lemery. Fish that succeed in making the seaward trip from Lake Taal, those that attempt the annual lakeward migrations from the open sea and fish which are either fixed or temporary inhabitants in Balayan Bay are likely to be caught in these *baklad.*

Pukot. (Pl. IV, fig. 7). Second in importance among the fishing methods employed in the catching of fish in Lake Taal is the *pukot.* The *pukot* is a seine several hundred meters long and a few meters wide. It is operated by from 16 to 24 men who serve as the oarsmen and fishermen at the same time. All the kinds of fish found in the lake are caught in this net.

A small seine-like net made of *sinamay* (a coarse thin textile made of abacá fiber) is used for catching fry of bañgos, *Chanos chanos*. (See Text fig. 3).

Bayakus. (Pl. IV, fig. 6). This is a comparatively small seine, the middle portion and the pocket of which are made of fine-meshed *sinamay*. This seine is operated by a smaller number of people than is required for the *pukot* and it is principally used to catch tawilis, *Harengula tawilis* Herre, the only member of the sardine family that is found in Lake Taal. Gobies and other smaller species of fish found in the lake are also caught in the *bayakus*.

Pante. (Pl. II, fig. 3). Gill nets are also extensively used in Lake Taal. The principal fishing centers where these nets are used are the barrios of the towns of Tanauan, Lipa, Talisay, and a number of fishing communities on Taal Volcano Island. There are two types of *pante*, or gill nets used; namely, the fine-meshed and the large-meshed nets. The former are used in catching tawilis, and is usually operated during night-time. They are set and allowed to drift at night and at early dawn they are collected to gather the catch (Pl. I, fig. 1). According to the information given by some veteran *pante* fishermen of Ambulong, Tanauan, the tawilis seem to be attracted by lights. This assumption is based upon the fact that the *pante* to which is attached a floating lantern catches the most tawilis. Unfortunately at the present time it is impracticable to use the lights because of fish net robbers; the lanterns help them to locate the nets. The large-meshed *pante* are operated to catch large fish, such as maliputo, *Caranx ignobilis* (Forskål); lumulukso (sexually mature), *Chanos chanos* (Forskål); boguin, *Hemiramphus quoyi* Cuvier et Valenciennes, and others.

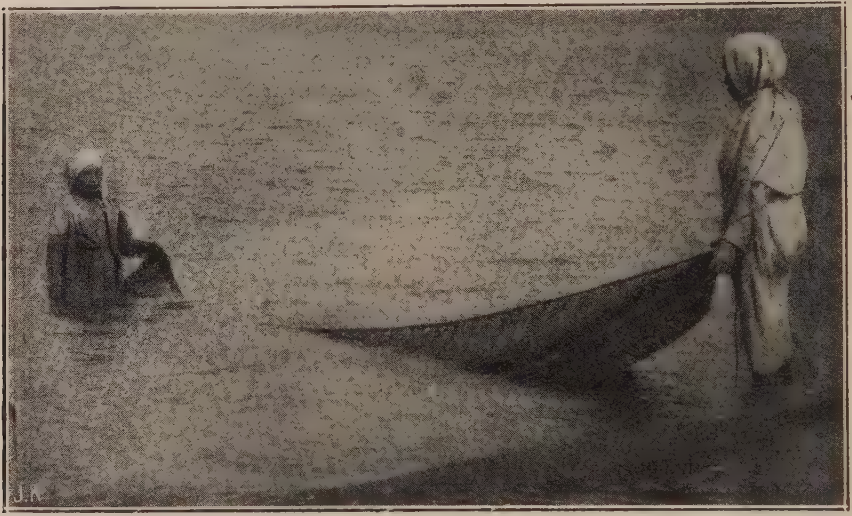


Text fig. 2.—*Bintol* used in Lake Taal to catch *katang* (small grapsoid crabs).

It may not be amiss to state here that the *pante*, *pukot*, and the *bayakus* which catch tawilis in Lake Taal are, from all indications, not factors that would bring about the depletion of the supply of tawilis. This assertion is based upon the fact that Lake Taal is so deep that no nets reach the bottom in the course of their operation. Consequently, there is seldom a catch of the entire school of the tawilis because only those which happen to migrate to the surface strata of the water are caught. Moreover, because no seines can reach the bottom of the lake, the ecological balance of the plant and animal organisms of the lake bottom remains undisturbed thus insuring the normal supply of food for these fish.

Hooks and lines are also used on Lake Taal for catching fish.

Kitang. This gear consists of set lines provided with hooks which are baited with tawilis, gobies, Taenioides, mollusks, katang (small crabs) and other suitable bait. The *kitang* catches dalag, *Ophicephalus striatus* Bloch; carangoid fishes, and others.



Text fig. 3.—Seine-like *sinamay* net used in catching bañgos fry in the mouth of the Pansipit River and along the shore of the west coast of Batangas Province. Incidentally, this net catches also fry and larvae of other fishes.

Biwas. This is a line and hook provided with a bamboo pole. It is usually baited with shrimps and catches gobies and other small fishes of Lake Taal.

Patukba. This is also a hook and line but tied to a small bamboo stick. Set in shallow portions of the lake where there is a thick growth of aquatic plants the hooks are baited with frogs. The *patukba* catches dalag, *O. striatus,* and hito, *Clarias batrachus* (Bloch).

Dala. Casting nets are also used in Lake Taal. The *dala* is conical in shape, made of fine-meshed netting, closed at one end, and the other end which is wide is weighted at the side with pieces of lead so that when it is thrown, it spreads and sinks into the water quickly. This net catches dalag, banak (Mugilidae), gobies, and other species of fish found in the lake. It is used in shallow portions of the lake.

Salap. Of the scissors nets used, two kinds were seen. The *salap* is a small scissors net made of fine-meshed *sinamay* and is used to catch mostly apta, minute prawns belonging to the family Atyidae. These prawns are sold fresh; dried for chicken feed; or heavily salted and made into *alamang*. *Alamang*, salted fermented prawns, is prepared in the same manner as *bagoong*, the only difference between the two being that the former is made from crustaceans, and the latter, from small fish.

Sakag. This is a much larger scissors net than the *salap*, and is made of fine-meshed netting. It catches mostly gobies, and other small species of fish found in Lake Taal.

Bintol. This is a small device made of a net rigged in a structure made by bending four pieces of sticks tied together (see text fig. 2). The *bintol* is baited and weighted with pieces of stone and dropped into the water. The bait, which is usually fish or pieces of meat, attracts crabs which are locally known as katang. (See discussion on the katang fishery).

Salapang. This is a spear or lance and used for catching large dalag.

Pana. This is a form of bow and arrow. The fisherman who operates this uses water eye-glasses to protect his eyes. He dives into the water, watches for a fairly large fish and then shoots it.

Bithay (Pl. III, fig. 5). This is a dredge-sieve made of bamboo splints. With it, the sand along the bottom of the Pansipit River is seived, thus separating the paros (mussels).

Fish poisons. Sometimes children catch fish by means of fish poison extracted from fruits of bayati, *Tinomiscium philippinense* Miers (Menispermaceae) crushed with katang (small fresh-water crabs) and applied in quiet portions of the Pansipit River. Gobies and other small fishes are thus caught.

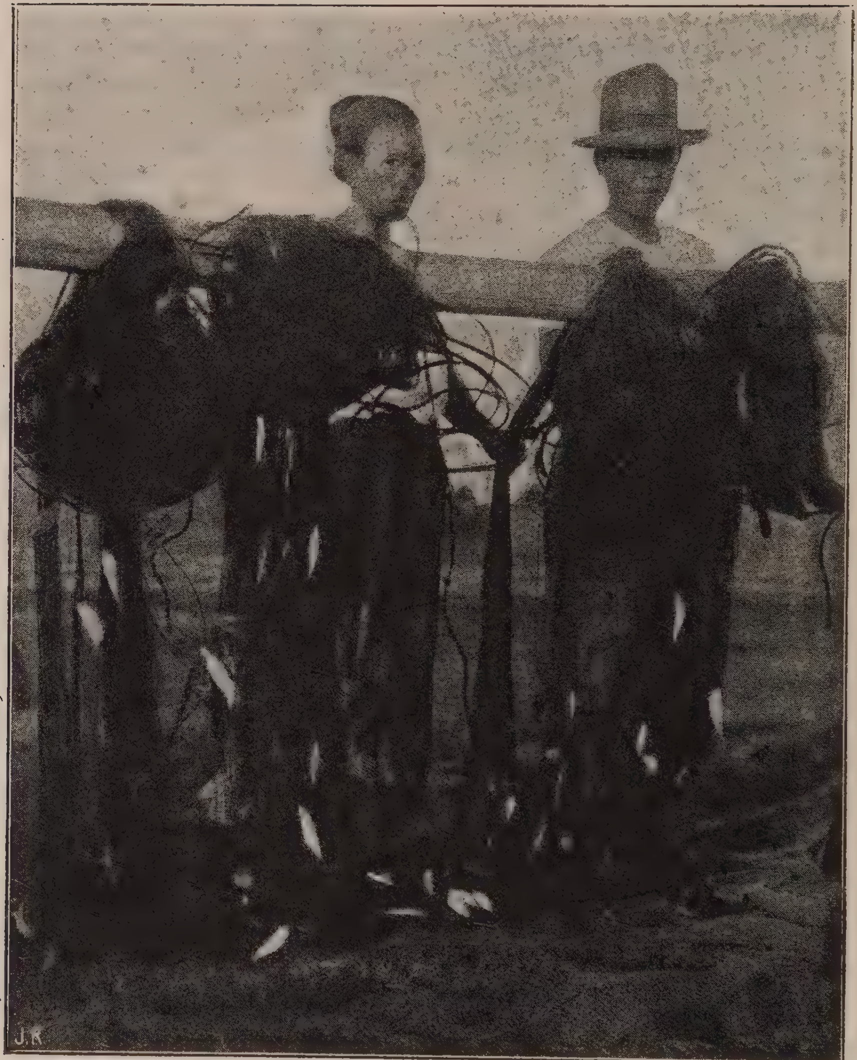


Fig. 1.—*Pante* just after removal from Lake Taal. Note tawilis, *Harengula tawilis* Herre entangled in the net. The fish are usually caught and held in the net by their gills; hence the *pante* and similar nets are known as gill nets.

PLATE I

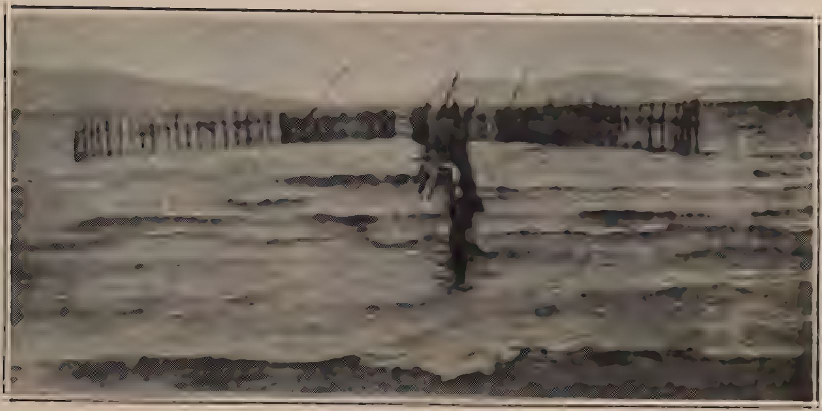


Fig. 2.—A typical fish corral of the *baklad bukana*.

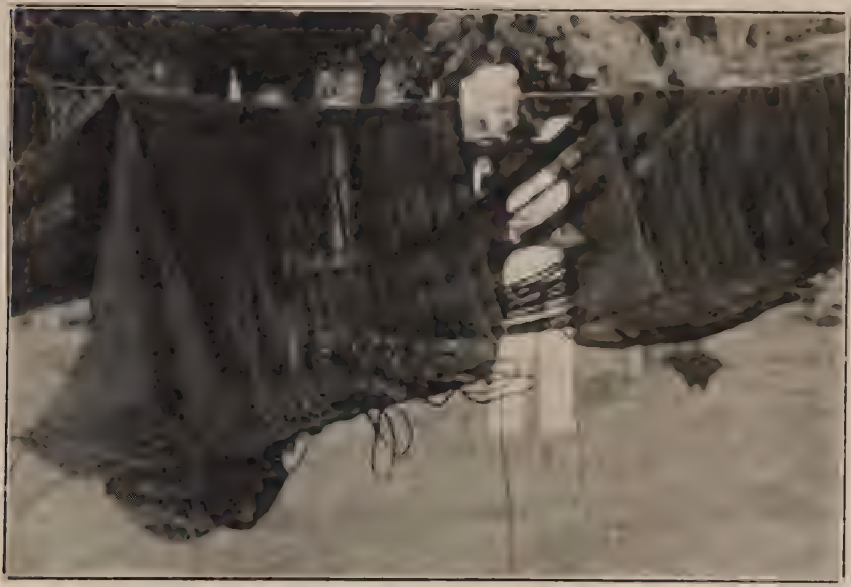


Fig. 3.—*Pante*, spread out to dry.

PLATE II

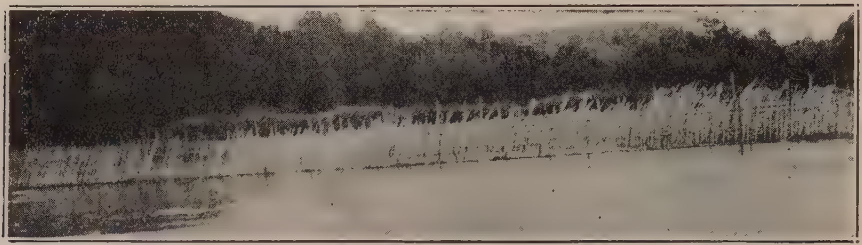


Fig. 4.—End view of the *baklad pansipit* facing Lake Taal. Note that the *baklad* blocks the entire width of the river.

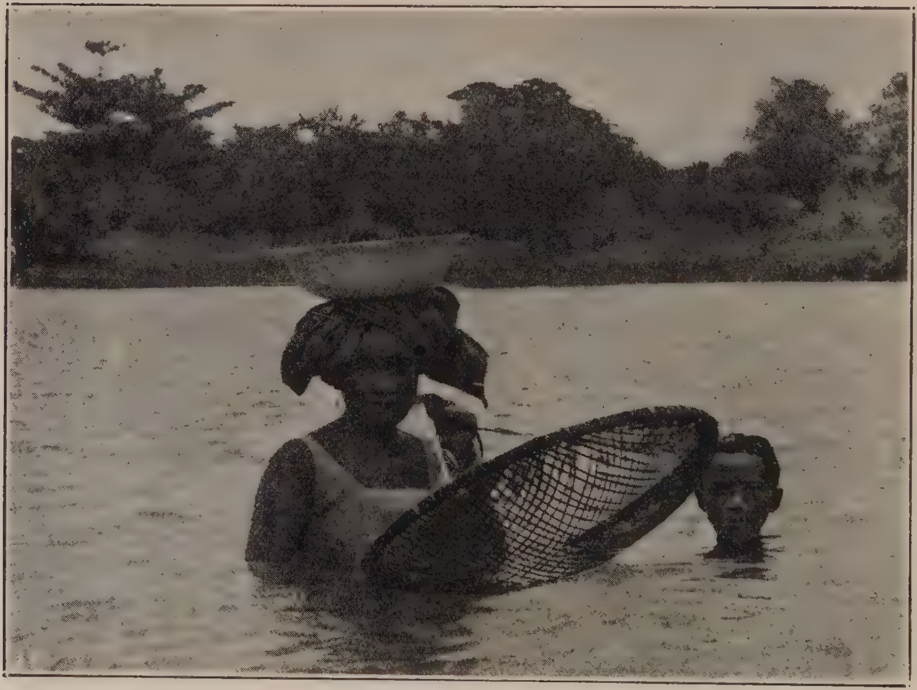


Fig. 5.—*Bithay* used in collecting *paros* (fresh-water mussels) in Pansipit River.

PLATE III

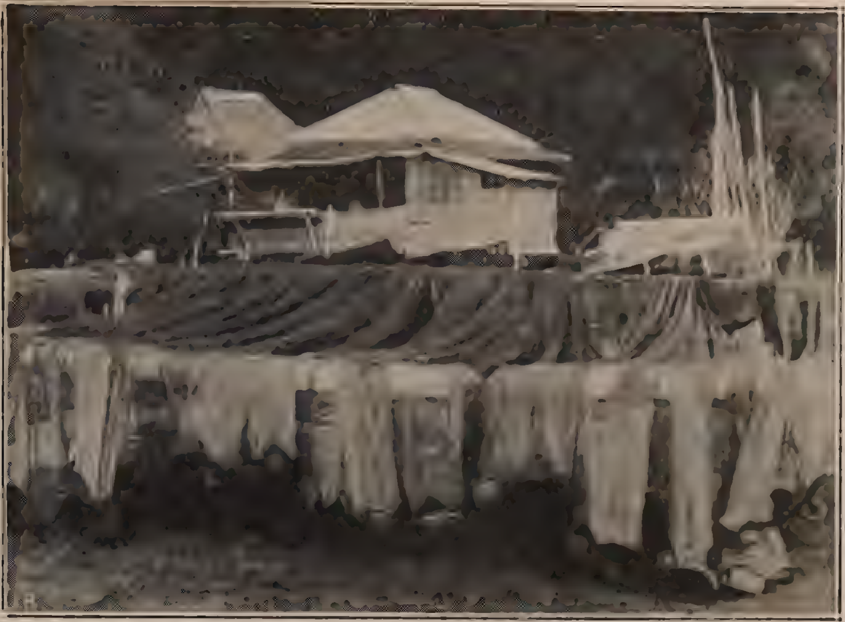


Fig. 6—*Bayakus* spread out to dry.

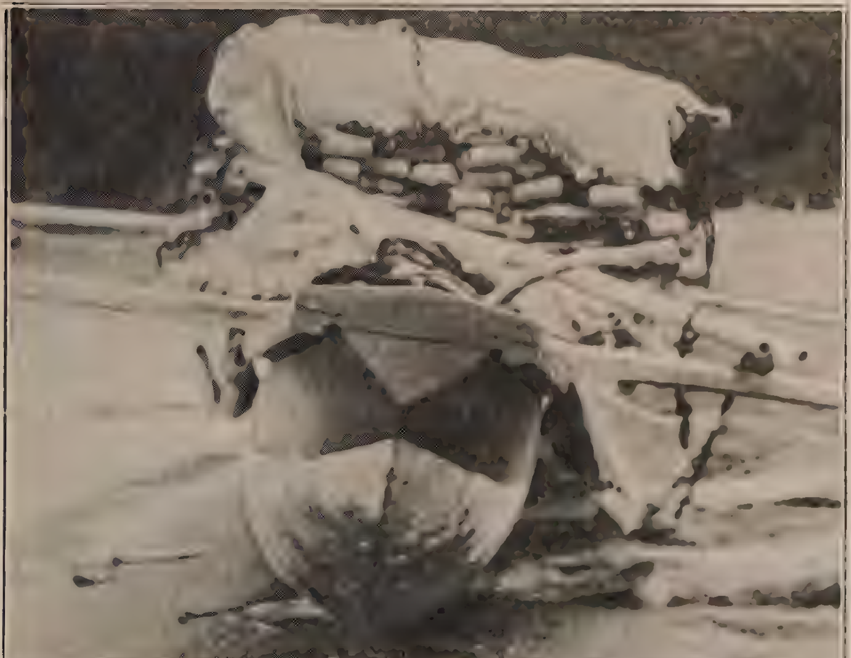


Fig. 7.—*Pukot* in Lake Taal ready to be taken out and used.

PLATE IV

THE PROXIMATE CHEMICAL ANALYSIS OF SOME PHILIPPINE FOOD PRODUCTS: IV[1]

F. T. ADRIANO AND M. S. DE GUZMAN
Of the Department of Agricultural Chemistry

In the Philippines, as in other countries, the people of one region have special food preparations which they esteem highly, but which are not known in other regions or if known are imported from the region where they are made. Such food as *balut*, *bagoong*, *patis*, and *achara* are illustrations of foods prepared in certain regions. But owing to an increasing demand, the production of some of these foods products is now on a commercial scale and the products are available practically in all seasons in most local markets.

A review of literature shows that information on the subject of Philippine food products is limited. Gibbs, Agcaoili and Shilling (1912) reported one of the earliest studies on the subject. They collected data on the manufacture and reported the analysis of *bagoong*, dried, salted and smoked, fishes, *balut*, locusts, *bihon*, *misua*, *mique*, toyo sauce and chocolate.

Adriano (1925) made a compilation of all available data on the proximate chemical analysis of Philippine foods and feeding stuffs. In this paper he included numerous analyses of foods and feeding stuffs made in the chemistry laboratory of this College.

Salazar (1925) prepared some soybean products (sauce and *tokua*) in the Department of Agricultural Chemistry of this College. He reported that "in the Philippines the use of these two soybean products is becoming more and more general." He further stated that *toyo* he prepared in the laboratory compared favorably in composition, odor and flavor with the superior grade products in the market.

Santos and Adriano (1928) prepared a compilation of the chemical composition of Philippine food materials. They analyzed various principal native foods and also some important food products.

Valenzuela (1928) studied the composition and nutritive value of Philippine food fishes.

Sherman (1929) in her feeding experiments reported that bean curd has a moderate amount of vitamin A and that it contains most of vitamin B originally present in the yellow soybean.

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[1] Experiment Station contribution No. 777. The data presented in this paper was reported by the junior author in a thesis presented for graduation from the College of Agriculture with the degree of Bachelor of Science in Agriculture October 1931. Thesis No. 412. Received for publication October 22, 1931.

Adriano (1929) with the coöperation of Manahan and Barros reported further studies on proximate chemical analysis of Philippine foods and feeding stuffs.

The work here reported was undertaken to determine the proximate chemical composition of some Philippine food products.

MATERIALS

The materials used were bought in the Manila, Cavite, and Calamba markets. A few of the samples were secured from stores in the vicinity of the College Campus.

Cereal products

Noodle (*bihon, Tag.*). This noodle is made from rice (*Oryza sativa* Linn.) flour. It resembles macaroni, excepting that it is whiter and smaller. Gibbs, Agcaoili and Shilling (1912) described the preparation of bihon as follows:

> The rice is first washed and then soaked over-night in water, ground between millstones to a finely divided liquid suspension, and run into linen bags or old flour sacks. After standing for about 24 hours, much of the water drains from the sack, the contents become firmer, and shrink about 25 per cent in volume. The rice is then kneaded by hand, or pounded in a wooden mortar with wooden hammers until homogeneous, and then patted into balls which are boiled in water for about one hour. They are then pressed through round holes in the bottom of a metallic box thus producing strings which are about three times as thick as vermicelli. These are again boiled for about an hour and then laid on bamboo frames, in flat boxes 15 or 20 centimeters square, and placed in the sun to dry. A day is sufficient for drying, after which they are ready for the market.

Noodle (*mique, Tag.*). This noodle is made from wheat flour in much the same manner as *misua* is manufactured. According to Gibbs, Agcaoili and Shilling (1912) "the dough is made with saline water to which is added a small quantity of alkali principally for the purpose of making the food a golden yellow. The alkali is usually obtained by leaching wood ashes or the ashes of tobacco stems, and the solution is used for mixing the dough. The dough is cut into strings about 20 centimeters long, boiled for two or three hours, and dried in the sun." Some Chinese manufacturers incorporate mungo (*Phaseolus aureus* Roxb.) flour in the mixture.

Noodle (*misua, Tag.*). This noodle is made from wheat flour. It resembles vermicelli. The dough is made by mixing the flour with salt water (weak salt solution 1-3 per cent). The dough is rolled into small ropes which are later stretched into fine long strings. These fine strings are dried in the sun. Some Chinese in Manila adulterate the wheat flour by adding sweet potato flour or rice flour when the dough is kneaded.

Noodle (*fideos, Tag.*). This noodle is made from a highly glutinous rice flour. It is colored yellow with artificial coloring matter. According to Mr. F. Segado, Acting Director of the Philippine Bureau of Commerce and Industry, *fideos* is manufactured in the following manner:

> With boiling water, the flour is converted into a dough of consistent thickness, and then made to pass through a certain device which cuts it into long tiny cylindrical shapes of almost uniform size and length. The resulting product is then dried in the sun.

Noodle (*sotanghon, Tag.*). This noodle "is made almost wholly from rice flour." *Sotanghon* is white and is crinkly. Mr. Segado says that *sotanghon* and *fideos* are made by practically the same process.

Tahure, (*Tag.*). *Tahure* is soybean curd which has been preserved in strong brine solution. According to Gibbs, Agcaoili and Shilling (1912) "*tahure* is imported from China in large stone jars. During shipments, the cakes are somewhat broken, giving to the liquid portion the appearance and consistency of an emulsion." The preparation of *tahure* is described under *tokua*. The solid and liquid portions were analyzed separately.

Bean paste (*miso, Tag.*). This paste is made from soybean, *Glycine max* (Linn.) Merr., and it looks like the *sapal* or residue from *tokua* (soybean curd) manufacture. It is prepared as follows: The beans are boiled in water until sufficiently soft, and then they are pounded in a wooden mortar to a thick paste. This paste is the *miso* sold in the market. The natural color of the beans is retained when the paste is still fresh, but it turns darker and becomes rancid when it is kept for a number of days. For this reason. it should be sold very soon after it is made.

Bean cheese (*tokua, Tag.*). This soybean food product is known to the Americans as bean-cake or bean-cheese; as *teo-fan* or *tao-hu*, to the Chinese; as *topu* to the Japanese; and as *tokua* to the Filipinos. (Salazar 1925).

The Chinese method of making *tokua* is as follows: The soybeans are soaked in water until pronounced swelling has taken place; then they are ground by hand between millstones. The milky liquid flowing from the mill is poured into a large container in which there is boiling water. The mixture is heated for one hour until it coagulates into a white curd. Some manufacturers use *batong sunsong*, or gypsum (mostly calcium sulfate) water to hasten coagulation. The curd is made into cakes of 8×8×3 cm., by folding it into a small piece of cloth and then pressing it in a hand press to expel as much of the water as possible. The cakes are left in the press for about 30 minutes; when taken out, the cloth is removed, and the compressed cakes baked in a moderate oven until light brown. The inside of the cakes remain a creamy white.

The *tokua* so prepared will not keep long. To preserve the cakes they are covered with a strong salt solution. These cakes are called *tahure*.

Soy sauce (*toyo, Tag.*). Toyo is the sauce made from the soybean and is called *shoyu* by the Japanese and *ch' an you* by the Chinese, soy sauce by the Americans and toyo by the Filipinos (Salazar 1925). According to Piper and Morse, as cited by Salazar (1925), soybean sauce is a most popular food product of some Oriental people. "In Japan alone the annual production of toyo amounts to considerably over 2,000,000 barrels, the per capita consumption being estimated to be about 2.5 ounces daily." A large amount of toyo comes from China into the Philippines, but there are many toyo factories in Manila which partly supply the local demand for soy sauce.

The preparation of toyo differs with different manufacturers only in some specific details. In general, the process, as described by Gibbs, Agcaoili and Shilling (1912) and Salazar (1925), is as follows:

The beans are boiled until they are soft to the touch. They are then placed in a sieve to drain off as much of the water as possible. The drained beans are put into large fermentation vats and a strong brine solution equal to one-third of the bulk of the beans is added. This mixture is placed in the open where the sun will strike in daytime and allowed to ferment from 2 to 4 months.

The fermented mass is boiled again for 12 hours, and after the solids have settled to the bottom, the supernatant liquid is decanted into other jars. This liquid which is dark brown in color is bottled and sold in the market as toyo. Different grades of toyo are produced by boiling and sunning repeatedly the fermented mass and extracting the clear filtrate.

Crustacean products

Salted shrimps (*bagoong alamang, Tag.*). *Bagoong* is a common food product made by the Filipinos in some regions from small shrimps and young or small fishes. In many homes it is a staple food while in others it is used only to flavor many dishes. *Bagoong* is produced in large quantities and of various kinds in the Ilocano provinces and in some of the Visayan islands.

Bagoong alamang is prepared by mixing 4 parts of the alamang (small shrimps, *Penaeus* spp.) and one part of salt. The mixture is allowed to ferment for from 5 to 10 days or until all the salt has dissolved. The salted alamang is then pressed; from the liquid drained off, *patis* and *heko* are recovered. The pressed alamang is pounded in a wooden mortar until it becomes like a paste. More salt is added and oftentimes *ankak*[3] is also added to improve the color. The whole is then allowed to season for about a day or two. The *bagoong* is then ready for the table; it is served either raw or is cooked with pork.

The samples analyzed in this work were *bagoong alamang* Cavite and *bagoong alamang* Zamboanga (as they are known in Manila markets). The only difference between the two is that the Zamboanga *bagoong* has undergone a longer period of fermentation (from 20-30 days) in the original salt solution than the Cavite *bagoong* and is not colored with any wood dye.

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[3] *Ankak* is fermented dried rice which is prepared by soaking rice in a kind of wood dye and then drying it. The dried colored rice is then powdered. It is this powder that is used in varying amounts to color the *bagoong* to the desired red tint.

Dried salt water shrimp (*hibe, Tag.*). *Hibe* is another food product of Chinese origin. Salt water shrimp (*Penaeus* spp.) ranging from 2 to 5 cm. long are cooked in a small amount of water. The skin and other non-edible parts are removed and the cooked shrimps sun-dried. The dried shrimps are sold in the market as *hibe;* this product is combined with meat. vegetables or rice in the preparation of many different kinds of dishes.

Dried fresh water shrimp (*hipong maalat, Tag.*). In making this food product in Laguna, fresh water shrimps (*Palaemon* spp.) are used. The shrimps are cooked in an earthen pot in water (just enough to cover them) to which salt (1 part of salt to 5 parts of shrimps) has been added. The cooked shrimps are dried in the open and then the *hipong maalat* is ready for use.

Condiments (*patis alamang Cavite, Tag.* and *heko, Tag.*). *Patis alamang* is the sauce obtained by boiling the extract pressed out from the salted and fermented small shrimps. Beef, shrimp and fish *patis* are prepared in a similar way. The *patis* analyzed in the present study was prepared as follows:

Two parts of small shrimps (*Penaeus* spp.) and three parts of salt were allowed to ferment for about 20 to 30 days in covered stone jars. The fermented mass was then pressed in a strainer to obtain the liquid portion. This brownish liquid was boiled until no more of the scum (*heko*) appeared on the top. The *heko* was skimmed off every now and then with a strainer ladle. When no more *heko* formed the liquid was cooled and allowed to stand until all the remaining sediment had settled. The clear liquid was decanted, bottled, and sold as *patis*. *Patis* is used as a condiment for almost any kind of viand. *Heko* is excellent for the preparation of salads and other dishes, and as a condiment for boiled vegetables.

Heko, (*Tag.*). *Heko* is the scum which rises to the surface in the process of *patis* manufacture. *Heko* is usually used to flavor food; seldom is it used as a separate dish. It is brownish black in color. The preparation of *heko* is described under "*patis* making."

Egg products

Incubated duck eggs (*balut, Tag.*). In Pateros, Rizal Province, *balut* is made from duck eggs. The industry is well established and about 50,000 eggs (*balut*) are exported weekly from that town. According to statistics from the Philippine Bureau of Commerce and Industry, in 1903 there were 3 *balut* establishments in the Islands with a capital of ₱8,200.00. The annual production was valued at ₱5,022.00 and the profit was ₱1,678.00. In 1918, the number of factories had increased to 14 with a total capital of ₱26,300.00. These 14 *balut* factories produced ₱48,927.00 worth of products and made an annual profit of ₱4,954.00.

The method of producing *balut* in Pateros is as follows:

The duck eggs are first selected for their *balut* possibilities. Then they are laid in the sun for about an hour, after which time they are bagged (100-120 eggs in a bag). These bags of selected eggs are put in cylindrical holes (about 1 meter deep and .5 meter in diameter), made in a permanent rectangular pile of palay husks or straw. The holes are covered and twice a day (usually early in the morning and late in the afternoon) the bags are opened and the eggs are given a turning over. This daily turning over is continued for 18 days. At the end of the first week, the eggs are subjected to the first candling test and those that fail to give any indication of a developing embryo are taken out. At the end of the second week, a second candling test is made for the same purpose. At the end of 18 days or about 3 weeks, the incubated eggs are boiled and sold as *balut*.

Salted duck eggs (*maalat, Tag.*). This is another food product made from duck eggs. *Maalat* is prepared as follows:

An equal mixture of clay and salt is prepared in a large basin. The fresh duck eggs are placed in the basin and covered with this clay-salt mixture and allowed to stay there for a number of days, usually three weeks. During this period the eggs have been sufficiently salted. They are removed from the salt mixture and boiled for about 15 minutes. They are then colored red to show that they are salted.

Hard boiled duck eggs (*penoy, Tag.*). The eggs which have been culled out by the first and second candling tests in the preparation of *balut* are boiled until hard and are sold as *penoy*.

Soft boiled eggs (*malasado, Tag.*). *Malasado*, soft boiled eggs is prepared by boiling a fresh chicken egg for about 1 to 2 minutes. At the end of this time the albumen of the egg is somewhat thickened while the yolk is scarcely heated.

Fish products

Seale (1914) reported that in many localities in the Philippines, fish are preserved on a commercial basis. According to statistics of the Philippine Bureau of Commerce and Industry, in 1918 there were 208 shrimp and fish drying and salting establishments in the Philippines. These had a total capital of ₱448,018.00 and an annual production of ₱1,981,094.00 and a profit of ₱418,402.00.

Salted anchovies (*bagoong dilis Cavite, Tag.*). *Bagoong dilis Cavite,* really a condiment, is made by mixing 2 parts anchovies (*Anchovia* spp.) with 3 parts salt. The mixture is allowed to ferment from 5 to 7 days. Then the liquid portion is drained off and replaced by a vinegar and *ankak* mixture. The colored, salted and fermented mixture is allowed to stand for 2 or 3 days more; it is then bottled, sealed and is ready for market.

Salted anchovies (*bagoong dilis Iloco, Tag.*). *Bagoong dilis Iloco* also is made from anchovies. The *dilis*, or anchovies are washed, drained, and put into large earthen jars, and salt is added (from 1-2 parts salt to 2-3 parts fish). The jars are tightly covered and the contents allowed to ferment for from 2 to 3 months. At the end of this time the *bagoong* is ready for market. According to the Ilocanos, the longer the period of fermentation the better the flavor.

Salted milkfish eggs (*bagoong itlog ng̃ bang̃os, Tag.*). This *bagoong* is made in much the same manner as the *bagoong alamang* Cavite, except, that instead of small shrimps, the eggs of milkfish (*Chanos chanos* Forskål) are used.

Dried salt fish (*daing, Tag.*). *Daing* refers to any kind of fish which has been salted and then dried. It is prepared as follows:

If the fish is large, it is cut open on the ventral side and the entrails removed. The fish is then washed and spread open and placed layer on layer in kerosene cans. Between each layer salt is sprinkled liberally. The salted fish are allowed to stand from 1 to 6 hours. They are then removed from the cans and dried in the sun for from 1 to 2 days. They are then ready for use or the market. Five kinds of *daing*, or dried salt fish are reported in this paper.

Smoked herring (*tinapa tunsoy, Tag.*). *Tinapa* is made as follows: The fish (in this case herring, *Harengula* spp.) are washed and drained properly, then boiled in a strong brine solution. When cooked, they are taken from the brine, allowed to drain, then dried in the sun for about 2 hours. Then they are placed in shallow, circular baskets or bamboo trays and exposed, in a closed room, to smoke (usually of bagasse) issuing from a hole in the top of an earthen oven. The basket or trays are placed one above the other and by continually shifting the ones from the bottom to the top and turning the fish over, they become uniformly and thoroughly smoked in about 5 to 10 hours.

Fruit products

Salted balimbi (*buro balimbi, Tag.*). This kind of *buro* is made from *balimbi* (*Averrhoa carambola* Linn.). The fruit after being properly prepared and washed is placed in a glass container and salt is added (the amount varying with the individual taste). The mixture is allowed to stand for about a day and then a small amount of water is added. At the end of another day, it is ready for the table.

Salted camias (*buro camias, Tag.*). This *buro* is made out of camias, (*Averrhoa bilimbi* Linn.). Both ends of the camias fruit are cut off, then it is carefully washed and drained. The fruit is put in glass containers and salt (1 part salt to 5 parts fruit) is added. The container is covered and the mixture is allowed to stand for at least a day then water is added and the fruit allowed to stand for a few days when it is ready for the table.

Salted green mango (*buro manga, Tag.*). *Buro manga* is made from sliced green mango (*Mangifera indica* Linn.). The green mangoes are peeled and sliced, then washed and put in glass jars and salted (1 part of salt to 3 parts of sliced mangoes). After a day, just enough water to cover the sliced mangoes is added. In about 2 days the *buro manga* is ready to be served.

When made to sell or on a commercial scale, whole green mangoes are used. They are prepared as follows:

A strong brine solution (5-10 per cent) is prepared in large stone jars called *tapayan*. The green mangoes are washed and put in the brine. The jars are covered and the mangoes allowed to stand for about 20 days with weekly inspection to test the concentration of the brine and to note the condition of the fruit. This test is made by simply tasting a little of the liquid. When the mangoes turn greenish yellow and become plump they are ready for the market.

Meat products

Crackling (*satsaron, Tag.*). Crackling is made principally from the skin of a butchered hog or the residue after lard has been tried out of the fat. When skin is used it is cleaned and dried in the sun. It is placed in hot lard and left until it is brown and crisp. It is occasionally sprinkled with water to make it puff up. *Satsaron* or *chicharon* is usually eaten with tomato salad or vinegar with some pepper and salt.

Vegetable products

Salted radish (*buro labanos, Tag.*). The leaves of the radishes (*Raphanus sativus* Linn.) are cut off to within 3 centimeters of the body. The pointed roots are also cut off. The radishes are then washed and air dried and split into halves or quarters, depending upon the size, but the parts are not separated. They are then placed in earthen jars in layers with salt between in the proportion of about 1 part of salt to 10 parts of vegetables and allowed to stand for a day. Then enough water in which rice has been washed is poured in to cover the whole and it is allowed to stand for about a week or until the vegetables become plump. They are then ready for use or sale.

Salted mustard (*buro mustasa, Tag.*). The roots of mustard, *Brassica integrifolia* (West) O. E. Schulz, are cut off leaving the bunch of leaves intact. These are put in the sun for a short period to wilt them. They are then salted in the same manner as the radish. Enough rice broth is poured over them to cover the vegetables. They are allowed to stand for about a week or until the liquid is sour. The *buro* is then ready to serve.

Miscellaneous products

Pickles (achara, Tag.). (Commercial pickles). *Achara* is the local name for any kind of pickles. The demand for pickles imported or of local manufacture is increasing. The Pacific Commercial Co. and Kwong Shing Yuen factory, both in Manila, are making pickles of various kinds.

According to Le Feure (1920), commercial pickles are made as follows: All vegetables which are to be made into pickles are properly cured in brine solution (separately, if produced on a large scale), just as in the case of cucumbers.[4] After this preliminary curing, if the vegetables are to be used for salt pickles, only partial processing is required but if they are to be made into sour, sweet or mixed pickles, the salt should be almost completely removed. In factories, processing is done by putting the vegetables in tanks filled with water and then the vegetables are subjected to a current of steam, stirring them at intervals. In the home, the processing is done by heating the vegetables to 120°F. from 10 to 12 hours in a kettle filled with water.

Then the processed vegetables are arranged in a wide-mouthed bottle in a neat and orderly manner so as to present a tempting appearance and to economize space.

If sour pickles are desired, the bottles are filled with vinegar (4 to 6 per cent acetic acid). If sweet pickles are desired, the bottles are filled with a sweet liquor made by dissolving 1.5 to 2.0 kilograms of sugar in four liters of vinegar.

The bottles are then sealed tightly with the aid of hot paraffin, and labeled properly.

Two kinds of commercial pickles were analyzed in this work.

Philippine home-made pickles (native pickles). The green papaya (*Carica papaya* Linn.) is peeled and grated, and the ampalaya (*Momordica charantia* Linn.) is cut into thick slices. Onions (*Allium cepa* Linn.), and garlic (*Allium sativum* Linn.) are peeled. Then papaya, ampalaya and onions are put in a porcelain basin and mixed with salt thoroughly by the hand.

A solution of nipa vinegar and sugar (about 5 per cent) is prepared. To this is added enough expressed juice of ginger root to give a mild ginger taste. The salted fruit and vegetables are put into a glass jar and the vinegar-sugar solution poured over them. The jar is covered and the contents allowed to stand for about two days when the pickles are ready to be served.

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[4] "The cucumbers are packed in barrels and an excess of salt, in the proportion of 1 lb. for every 10 lbs. of cucumbers. Since the active stage of a cucumber fermentation continues for a period of from 10 to 30 days, the addition of salt should be gradual so as not to reduce the acid forming power of the essential organisms and thus insure successful fermentation. This gradual addition should extend over a period of weeks. Complete curing of the pickles requires from one to two months. This can be recognized by an increased firmness in texture, a greater degree of translucency, and a change in color from pale green to a dark or olive green."

Some directions for the preparation of various native pickles are given in *Elementary Home Economics*, a text book for intermediate school girls, prepared by the Philippine Bureau of Education. Orosa (1928) also described some methods of preparing different native *acharas*.

METHODS

With certain modifications, the methods of analysis followed were those adopted by the *Association of Official Agricultural Chemists* (1925), and those given by Mahin (1919) and Winton 1917).

RESULTS

The results of the proximate chemical analysis of the 42 Filipino food products studied are given in the table. The figures given represent the average of two concordant determinations.

SUMMARY

1. Forty-two Philippine food products were studied and analyzed.
2. With the exception of the soybean paste (*miso*) and curd (*tokua*), and *bagoong itlog ñg bañgos* and *tinapa tunsoy*, the leguminous, crustacean and fish products are high in ash content.
3. Generally, the proportion of crude fiber to total solids in fruit, vegetable and miscellaneous products is higher than in the other foods studied.
4. Crackling is a good source of fats; eggs, fish, the crustaceans, cereals, the legumes, vegetables, fruit and the miscellaneous products contain fats, but in lesser amounts.
5. As a source of protein, crackling leads; eggs, fish, the crustaceans, cereals, legumes, vegetables, fruit and miscellaneous products contain protein but in lesser amounts.
6. Among the foods studied cereal products are the highest in starch content.
7. The greater portion of the ash of *tahure*, soybean sauce, the crustaceans, fish (except *dilis*). fruits, vegetables and miscellaneous products, is sodium chloride.
8. In degree of acidity, the food products studied may be placed in the following order: fruit, fish, crustaceans, eggs, ceréals and legumes, meat and vegetables.
9. Cereals are good sources of carbohydrates (nitrogen free extract).
10. The calorific value (food value) of foods prepared from cereals is much higher than those made from leguminous products. Dried salt water shrimp and dried fresh water shrimp have a higher calorific value

than salted and fermented shrimp, *heko* and *patis* (condiment). Egg products have almost the same calorific value. All the kinds of *bagoong* under fish products have lower food value than the *daings*, *dilis* and *tinapa tunsoy*. The fruits, vegetables and miscellaneous products studied have low calorific value. Crackling, the only meat product studied, has the highest calorific value among the foods analyzed. It is rich in protein and fat.

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The chemical composition of some Philippine food products

	EDIBLE PORTION	MOISTURE	TOTAL SOLIDS	ASH	CRUDE FIBER	ETHER EXTRACT	CRUDE PROTEIN	STARCH	SODIUM CHLORIDE	ACIDITY CC. OF 0.1N NaOH PER 100 GRAMS	(CARBOHYDRATE) NITROGEN FREE EXTRACT	CALORIES PER 100 GRAMS
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*cc.*	*per cent*	*calories*
Cereal and leguminous products												
1. Bihon[a] (rice noodle)		9.51	90.49	0.72	0.30	1.56	5.04	17.33	0.41	21.3	82.87	375
2. Fideos (rice noodle)		10.03	89.97	0.34	0.10	0.78	3.32	63.06	0.26	25.2	85.43	371
3. Mique (wheat flour noodle)		45.42	54.58	3.16	——	0.97	9.80	26.15	1.81	——	40.65	216
4. Miso (soybean paste)		69.56	30.44	2.19	5.77	1.57	13.40	0.18	0.87	68.3	7.51	100
5. Misua (wheat flour noodle)		10.49	89.51	6.10	0.26	2.14	10.26	30.24	4.55	27.3	70.75	352
6. Sotanghon (rice flour noodle)		10.33	89.67	0.91	——	0.96	5.11	80.87	0.75	19.4	82.69	369
7. Tahure (Solid portion		58.41	41.59	19.15	——	6.67	6.36	2.80	10.14	97.7	9.41	125
(Liquid portion[1]		67.35	32.65	20.64	——	2.49	2.89	2.15	14.58	67.2	6.63	62
8. Tokua (soybean curd)		72.74	27.26	1.15	——	3.50	14.24	——	0.54	49.0	8.37	125
9. Toyo, soybean sauce from Kwong Me Chan,[2] Manila		63.43	36.57	23.32	——	0.80	2.14	4.38	21.44	72.6	10.31	59
10. Toyo, soybean sauce, "Sol"[3] brand from Sengkee and Co., Manila		63.36	36.64	21.58	——	1.07	4.35	4.33	19.01	93.9	9.64	67
11. Toyo, soybean sauce, "Great Eastern"[4] brand from Azcarraga, 1601, Manila		62.15	37.85	23.68	——	1.22	2.37	5.23	21.56	95.5	10.58	64
12. Toyo, soybean sauce, "Violin"[5] brand from Philippine Products Manufacturing Co., Manila		61.61	38.39	23.68	——	0.92	6.87	3.78	15.80	69.9	6.92	65
13. Toyo, soybean sauce, "Rooster"[6] brand from Kwong Shing Yuen, Manila		60.74	39.26	19.33	——	3.73	2.93	11.24	10.16	111.9	13.27	100
Crustacean products												
1. Bagoong alamang Cavite (salted and fermented shrimps)		69.76	30.24	14.71	——	2.77	12.21	1.01	12.18	197.0	0.55	78
2. Bagoong alamang Zamboanga (salted and fermented shrimps)		59.91	40.09	20.60	1.29	4.54	12.24	1.34	16.10	81.8	1.42	98
3. Heko (scum from patis manufacture)		65.72	34.28	19.06	——	0.60	13.44	0.38	16.66	40.4	1.18	65
4. Hibe (dried salt water shrimps)		23.07	76.93	12.99	1.72	2.46	49.58	1.05	7.48	26.5	10.18	267
5. Hipon maalat (dried fresh water shrimps)	29.0	37.69	62.31	20.67	2.45	1.15	32.17	0.88	2.22	30.6	5.87	166
6. Patis alamang[7] Cavite (boiled sauce from fermented shrimps)		67.52	32.48	24.59	——	3.70	5.69	0.74	17.19	60.7	——	59
Egg products												
1. Balut (incubated duck eggs)	89.9	69.78	30.22	0.98	——	13.00	14.99	0.87	0.29	78.4	1.25	185
2. Maalat (salted duck eggs)	89.8	67.92	32.08	3.45	——	11.50	13.13	1.55	3.01	99.8	4.00	175
3. Malasado (soft-boiled duck eggs)	87.7	74.03	25.97	0.91	——	13.03	11.13	0.57	0.20	25.5	0.90	168
4. Penoy (hard-boiled infertile duck eggs)	89.2	70.88	29.12	1.00	——	14.20	12.57	1.00	0.32	44.4	1.35	186

[a] Tagalog common names used throughout

Specific gravity
1—1.2276
2—1.2489
3—1.2309
4—1.2411
5—1.2512
6—1.2600
7—1.2195

The chemical composition of some Philippine food products

	EDIBLE PORTION	MOISTURE	TOTAL SOLIDS	ASH	CRUDE FIBER	ETHER EXTRACT	CRUDE PROTEIN	STARCH	SODIUM CHLORIDE	ACIDITY CC. OF 0.1N NaOH PER 100 GRAMS	(CARBOHYDRATE) NITROGEN FREE EXTRACT	CALORIES PER 100 GRAMS
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*cc.*	*per cent*	*calories*
Fish products												
1. Bagoong dilis Cavite (salted anchovies)		68.73	31.27	16.66	——	1.87	9.51	0.95	13.85	313.0	3.23	69
2. Bagoong dilis Iloco (salted anchovies)		62.77	37.23	24.53	——	2.20	9.60	1.06	16.10	154.7	0.90	63
3. Bagoong itlog ng bangos (salted milkfish eggs)		87.15	12.85	2.41	——	2.11	5.82	0.42	2.09	212.7	2.51	53
4. Daing ayungin [dried salted fish (*Datnia phembea Kner*, Theraponidae)]	50.6	26.56	73.44	26.76	0.44	3.73	38.88	2.17	12.36	67.1	3.63	208
5. Daing bacalao [dried salted fish (*Gaduc callarias* Linn. Galidae)]	90.3	26.43	73.57	18.57	0.26	0.88	45.83	7.98	16.87	135.6	8.03	229
6. Daing dalag [dried salted fish (*Ophicephalus striatus*, Gloch Ophicephalidae)]	60.1	30.65	69.35	16.50	0.55	1.90	47.80	2.55	10.43	106.2	2.60	224
7. Daing kandule [dried salted fish (*Arius* spp., Ariidae)]	54.8	26.51	73.49	18.88	0.54	2.39	42.67	——	14.74	88.8	9.01	234
8. Dilis (dried salted fish (*Anchovia* spp., Engranlidae)]		24.80	75.20	30.82	0.48	6.81	36.07	0.92	3.15	69.6	1.02	214
9. Tinapa tunsoy [smoked herring (*Herengula* spp.)]	90.1	48.18	51.82	6.01	——	9.07	36.22	——	4.33	167.0	0.52	233
Fruit products												
1. Buro balimbi (salted balimbi)		85.28	14.72	5.35	0.77	1.56	0.14	1.02	4.67	77.5	6.90	43
2. Buro camias Solid portion—(salted camias)		91.44	8.56	2.28	1.31	0.94	0.69	0.90	1.01	348.1	3.34	25
Liquid portion		96.15	3.85	2.35	——	0.17	0.23	——	1.72	173.2	1.10	7
3. Buro manga (sliced) solid portion, salted green mango		82.60	17.40	3.31	0.81	0.11	0.81	6.15	1.00	307.4	12.36	55
4. Buro manga (whole) solid portion, salted green mango	80.1	83.87	16.13	3.81	1.11	0.14	0.66	3.61	2.92	163.5	10.41	47
Meat products												
1. Satsaron (crackling)		2.81	97.19	0.99	——	26.39	55.63	——	0.59	26.3	14.18	526
Vegetable products												
1. Buro labanos (salted radish)		94.30	5.70	2.42	0.85	1.11	0.27	0.59	1.71	11.5	1.05	16
2. Buro mustasa (salted mustard)		91.12	8.88	3.80	1.62	0.48	2.68	1.19	2.81	21.5	0.30	17
Miscellaneous products												
1. Achara (pickles) "Rooster" brand from Kwong Shing Yuen, Manila		97.68	2.32	0.78	0.60	0.09	0.49	0.98	0.48	520.8	0.36	4
2. Achara (native pickles)		93.89	6.11	2.72	0.49	0.45	0.25	0.94	2.10	262.7	2.20	14
3. Achara (mixed pickles) "Concha" brand from P. C. C., Manila		95.02	4.98	3.00	0.08	0.28	0.58	2.05	2.16	552.2	1.04	9

A SIMPLE DEVICE FOR FUMIGATING WOODWORK OF BUILDINGS WITH CARBON BISULPHIDE[1]

LEOPOLDO B. UICHANCO
Of the Department of Entomology

One of the greatest setbacks in connection with the use of lumber of the softer grades in the Philippines is its susceptibility to attack by certain species of wood-destroying insects. Hardwood, however, is often prohibitively expensive because of the limited supply, and is, moreover, difficult to work. For these reasons, many inferior kinds of wood continue to be largely used in building and making furniture. Consequently, the average housekeeper has to keep on contending with unwelcome insect intruders that reduce the woodwork to empty outer shells of paper-like thinness.

Among the more serious insect enemies of woodwork in the Philippines are certain species of small beetles of the families Bostrychidae and Lyctidae and termites of at least three species; namely, *Cryptotermes cynocephalus* Light, *Cryptotermes nocens* Light, and *Coptotermes vastator* Light. The last-named species lives in the soil and attacks wood from its underground home as a base. Hence, infestation by this species may to a large extent be prevented by taking the proper precaution during construction to isolate posts and other wooden parts of buildings with cement bases and metal sheets, as recommended by other authors. However, the two species of *Cryptotermes* are the "dry-wood termites," or *únos*; the entire colony, including the sexual reproductive forms, lives in wood and has no ground connection. Likewise, the powder-post beetles and pinhole borers lay their eggs and pass the younger stages in wood. In houses in which the cheaper grades of lumber are used, these exclusively wood-inhabiting pests usually present a most persistent and, frequently, exasperating problem.

The externally visible manifestation of infestation is the presence of an accumulation of piles of fine woody fecal powder in the case of the beetles and coarse, compressed fecal pellets of wood in the case of dry-wood termites. The openings of tunnels in the wood are often readily visible in bostrychids and lyctids; but these are not so easily seen in dry-wood termites. Remedial measures should be applied as soon as these signs of infestation are noticed; in fact, a periodical, systematic inspection of the woodwork and furniture in all parts of the premises should be conducted regularly. When the pests are allowed to have their way for a long time, they produce a large number of offspring which extend their galleries deeper into the wood, where it is difficult, if not impossible, to reach them with insecticides. Likewise, in many cases, the wood becomes so completely overrun with the pests that it is no longer worth the trouble and expense of saving; and in this case the only alternative is to change the infested with new parts.

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[1] Experiment Station contribution No. 782. Received for publication August 26, 1931.

Of the various methods recommended for the control of these wood-infesting insects, we found in our experience that the old practice of fumigating the galleries with carbon bisulphide is about the simplest, least expensive, and most dependable. There are only two relatively minor objections to the use of this substance: (1) It is highly inflammable and (2) it tarnishes metals, like gold and silver. These disadvantages are, however, easily overcome.

In large bostrychids, like *Xylothrips flavipes* Illiger, the openings of the tunnels are quite large and there are only a few of them together on a piece of infested board, so that it is an easy matter to insert into each hole a small bit of cotton saturated with carbon bisulphide, and a small pinch of soft soap or clay dabbed on to keep the poison gas from escaping. However, in the case of the smaller borers, and, also, the dry-wood termites, this method will not work. Repeated attempts by the writer with carbon bisulphide fumigation of boards infested by these pests failed in the past, because of the difficulty in making the gas penetrate the galleries in sufficient concentration to kill the insects. In these earlier attempts, newspaper sheets or pieces of oilcloth of convenient sizes were tacked on as covers after application of the insecticide. The pests seemed to remain unmolested by the treatment, as indicated by the continued appearance of piles of fecal matter. Obviously, the fault was not with the carbon bisulphide, but with the method of application. Finally, a modification in the technique was resorted to. The newspapers, folded in double sheets, were soaked in water for a few minutes before using. As in our former practice, in the case of dry-wood termites, a wad of cotton about the size of half a hen's egg was dipped into carbon bisulphide and then placed against the opening of the insects' tunnels. Since carbon bisulphide costs only around one peso a kilogram, the material used for treating a colony can at most cost only about one centavo. A suitable piece of the double thickness of wet newspaper was then torn out and applied as cover in such a way that the edges adhered on all sides firmly to the wood. This was done by patting them down with wet fingers. Usually there was no difficulty encountered in getting the edges to stick, but, if necessary, more water was added to the edges with the aid of the fingers. A cover of this kind has been found in our work to be far superior to others we had used, and it could be fixed in position in a small fraction of the time necessary to put dry newspapers or oilcloth in place with the aid of thumb tacks.

Water, which formed a continuous sheet surrounding the carbon bisulphide, had a lower specific gravity than the latter substance and, hence, effectively prevented the gas from escaping, except through the bores and galleries of the insects.

Our experience with the dry-wood termites is that, during the initial stages of infestation, the fecal pellets of compressed woody matters are usually deposited in small piles in corners, usually where the wall joins the floor or the framework. When these pellets appear in compact piles, that is. not scattered about, we take it that they mark an opening to the pest's galleries. If they are scattered about, the natural interpretation is that the infested wood is located elsewhere—further up; that is, unless, of course, the broom had disturbed the piles during the morning's house-cleaning. With the nature of the piles of pellet as guide, therefore, one may be able to determine the location of the opening to the termites' tunnels. When the pile is in compact mass, the cotton wad containing carbon bisulphide may be placed on top of it and in this way the source of the poison gas becomes located against the opening.

In more advanced cases, cavities may be located by tapping the woodwork at various points near the fecal pellets with the handle of a pocket knife. A small opening is pried into the upper part of a cavity and the treated cotton fixed against it.

In our trials with the wet newspaper cover, we found that the edges remained in close contact with the wood for at least over-night. Even in an open porch, with a typhoon raging outside, all of our covers were found undisturbed the following morning. There was, therefore, sufficient time to allow the gas to be forced into the cavities and kill the insects. The newspaper covers were then removed and the pellet piles cleaned out, so as to ascertain whether or not fresh ones would be formed. In one or two weeks' time, one could tell if the treatment was effective; if not, the treatment was repeated. In our work, when dealing with compact fecal piles, fumigation with the aid of wet newspaper cover very rarely had to be done more than once or twice for each colony.

The control of powder-post beetles and pinhole borers is somewhat more difficult, because usually when infestation begins to be noticed, a wide surface area of the attacked wood is already riddled with numerous minute openings. Unless the case was too far advanced, however, we were occasionally able to kill the insects with the carbon bisulphide and wet newspaper treatment. Care was, of course, taken that the wad of cotton was placed above the location of the openings, by fixing it on with tacks, so that the carbon bisulphide gas, which is heavier than air, could get into the holes. Usually, however, the best method of controlling these beetles is to avoid using susceptible wood, especially lumber that shows signs of infestation.

A STUDY OF THE RESULTS OF THE FIRST PHILIPPINE EGG LAYING CONTEST[1]

F. M. FRONDA
Of the Department of Animal Husbandry

The First Philippine Egg Laying Contest was started in the College of Agriculture at Los Baños on September 1, 1930. This contest ran for a full year, 365 days, and closed on August 31, 1931.

The regulations under which the First Philippine Egg Laying Contest was conducted were the following:

1. This contest will begin September 1, 1930, and will terminate August 31, 1931.
2. Each pen shall consist of ten standard-bred pullets of the same variety with three additional pullets as alternates to take care of mortality or other losses during the contest. No males should be included.
3. The College will supply all leg bands for the entries.
4. The sum total of all eggs produced by the ten highest producing hens of each entry at any given time of the contest will determine the position of that pen in the contest.
5. All eggs laid will be sold at current prices and the proceeds will be used to cover the expenses in operating the contest.
6. The entry fee will be FIVE PESOS (₱5.00) a pen. This fee must accompany the application.
7. All entries must be in some time during the week before the contest opens. After the fowls have been placed in the contest pens, no entry may be withdrawn. Any contestant failing to abide by the rules of the contest subjects his pen to confiscation and the birds will be sold out and the proceeds credited to the contest.
8. The College reserves the right to reject any entry and to kill, burn or otherwise dispose of any bird or birds whose presence, owing to disease or other cause, may constitute a hazard to other birds in the contest. The College also reserves the right to clip the flight feathers of one wing of any bird which persists in flying over fences.
9. Every reasonable precaution will be taken to protect the fowls and prevent loss, but the College will not be responsible should death or losses occur.
10. A trap nest record of each pullet will be kept, and records of the pens every month will be reported. Abnormally small eggs will not be given official credit. All eggs laid outside of the trap nest will be recorded and these will be equally divided among the hens in the pen in determining the total cost of marketable eggs produced by the pen.
11. Any contestant may enter a second pen of a different variety or of the same variety, provided the second pen does not keep out a first entry of another contestant. All entries will be filed and recorded in the order in which they are received.
12. All entries shall be shipped prepaid to College Station. The fowls will be returned to their respective owners at the close of the contest at their expense. In case an entry is deemed unsuitable and is returned to its owner, the entry fee will be returned.

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[1] Experiment Station contribution No. 778. Received for publication November 14, 1931.

Entries. Eight pens were entered in this contest. The breeds represented, together with the names of the owners, were as follows:

1. S. C. White Leghorn, P. Darbey & Son, Port Hammond, British Columbia, Canada.
2. Los Baños Cantonese, Hacienda Hermanas Nable José, Tayug, Pangasinan.
3. Los Baños Cantonese, College of Agriculture, Los Baños, Laguna.
4. Los Baños Cantonese, Dr. Fernando C. Ordoveza, Bay, Laguna.
5. Nagoya, Y. Imamura, 20 Gomez St., San Juan, Rizal.
6. Mikawa, Y. Imamura, 20 Gomez St., San Juan, Rizal.
7. S. C. Rhode Island Red, Hacienda Carmelita, San José del Monte, Bulacan.
8. Nagoya, College of Agriculture, Los Baños, Laguna.

Ration used. The College of Agriculture laying ration was used throughout the year. This consisted of equal parts of grain, composed of the same amounts of corn and palay, and of mash made up of four parts, by weight, of rice bran, three parts of copra meal, one part of corn meal and two parts of dried shrimps. Minor changes had to be made in the composition of the feed in all pens during a certain part of the year, but these changes were made gradually. At current prices, the cost of this feed was ₱0.0685 a kilogram of grain and ₱0.0881 a kilogram of mash. The average cost of the ration was therefore ₱0.0783 a kilogram.

Care and management. As the birds arrived a few days before the contest started, they were placed in temporary quarters and given the contest feed. The grain was given morning and afternoon and the mash was given in dry mash hoppers that were kept open at all times. A similar system of feeding was followed after the birds were transferred to the contest houses on September 1, 1930. All feeds consumed were carefully recorded. Broody hens were placed in broody coops as soon as these were noted, and released three or four days later. The contest house, 1.8 meters by 2.4 meters, is provided with two adjoining grassy yards, which were rotated at regular intervals depending upon the supply of green feed in the yard. Each yard is about seventy-two square meters in area. As the fruit trees in the yards were newly planted, very little shade was available to the birds outside the house. Each entry was penned in one house.

Egg production. Careful records were made of egg production. All eggs produced were weighed in the afternoon of the same day they were laid. Only the trapnested eggs of the ten highest birds in the pen were included in the official pen production. All eggs produced in this contest were sold at current table egg prices, based upon the following classification and with the corresponding prices per dozen:

C. A. Extras (56 grams or over each)	₱0.72
C. A. Standards (45 to 55 grams each)	0.60
C. A. Undergrades (44 grams or less each)	0.48

All unidentified eggs, "out" eggs, were included in the computation of the returns from the sale of eggs, after these had been equally distributed on the basis of ten birds. However, the "out" eggs were not included in the computation of the official records of each pen.

RESULTS AND DISCUSSION

Egg production. Five birds entered in this contest made a record of over 200 eggs each. The highest record of individual egg production was made by a Nagoya pullet, No. 421, Entry No. 8, with 242 eggs to her credit. This was followed by a Los Baños Cantonese pullet, No. 69, Entry No. 4, with 219 eggs. A Rhode Island Red pullet, No. 124, Entry No. 7, followed closely with a record of 216 eggs. Two S. C. White Leghorn pullets, Nos. 9 and 4, Entry No. 1, occupied the fourth and fifth places with records of 215 and 212 eggs each, respectively.

Regarding the total egg production of each entry, Los Baños Cantonese fowls, Entries No. 4 and 3, occupy the first and second places, with a total annual production of 1,643 and 1,547 eggs each pen, respectively, or an average of 164.3 and 154.7 eggs each pullet. Entry No. 8, Nagoya, occupies the third place with a total pen production of 1,459 eggs. This is closely followed by Entry No. 6, Mikawa, with a total production of 1,444 eggs. Contrary to expectation, the S. C. White Leghorns laid the smallest number of eggs, probably because these birds were total strangers in this country. Entry No. 2, Los Baños Cantonese, Entry No. 5, Nagoya, and Entry No. 7. Rhode Island Red, occupy the fifth, sixth and seventh places, respectively.

According to the breeds represented in the contest, the Los Baños Cantonese fowls were observed to be the most productive, the three pens entered having a total production of 4,563 eggs or a percentage production of 41.6. The Mikawa with a total production of 1,444 eggs, 39.4 per cent, was second. The two entries of Nagoya pullets had a total production of 2,814 eggs or 38.5 per cent. The S. C. Rhode Island Red and the S. C. White Leghorn entries each had a total production of 1,297 eggs, 35.5 per cent, and 1,092 eggs, 34.2 per cent, respectively.

The highest record made by individuals of these breeds, with the exception of that of the Mikawa, are all over the 200-egg mark. The Nagoya holds the contest record of highest individual egg production, 242 eggs. This is followed by the Los Baños Cantonese with a record of 219 eggs. The highest record made by the S. C. Rhode Island Red was 216 which was followed very closely by that of the S. C. White Leghorn with a record of 215 eggs. The highest record made by the Mikawa was only 194 eggs.

"Out" eggs. Of the total production of the contest pens in the entire contest of 12,416 eggs, 11,210 eggs were laid in the trap nests and credited to specific individuals and the rest, 1,206 eggs, were laid either outside the

nests or inside but the birds that laid them were able to escape without the numbers having been recorded. This number of "out" eggs represents 9.71 per cent of the total number of eggs produced by the ten competing birds in each of the pens of the entire contest. Entry No. 2, Los Baños Cantonese, had the smallest percentage of unidentified eggs, 5.70 per cent, and Entry No. 6, Mikawa, had the highest, 13.43 per cent. When these "out" eggs were distributed on the basis of ten birds and added to the corresponding pens, the individual pen production, arranged in the order of the number of entries from 1 to 8 was as follows: 1,229; 1,456; 1,718; 1,788; 1,495; 1,668; 1,484; and 1,578 eggs.

The "out" eggs, to a certain extent, raised the average individual egg production of the birds in the contest, but this corrected individual record cannot be taken as official. The production of "out" eggs cannot be prevented in any trapnesting operation, as there are birds that get into the bad habit of laying either on the floor of the house or on the dropping boards. The mechanical troubles of the trap nests may also be an important factor in the production of unidentified eggs.

TABLE 1

Showing the distribution of egg production of the different breeds in the contest

MONTH	BREEDS					ALL BREEDS
	S. C. White Leghorn	Los Baños Cantonese	Nagoya	Mikawa	S. C. Rhode Island Red	
September	31.7	41.5	33.8	40.3	40.0	38.5
October	4.8	43.9	45.2	29.0	47.1	39.3
November	19.3	39.9	33.2	28.3	29.0	33.6
December	40.5	46.3	44.2	58.7	42.9	46.3
January	47.7	51.3	51.0	50.6	49.3	50.7
February	53.2	43.2	39.9	48.6	46.8	44.5
March	48.1	43.7	48.7	49.3	47.7	46.9
April	37.4	45.5	46.0	36.3	32.0	40.6
May	39.8	49.3	42.3	42.9	36.8	41.9
June	48.3	39.6	37.2	51.7	32.0	39.9
July	42.8	40.9	45.3	47.7	31.0	38.7
August	38.3	37.1	37.9	48.7	24.5	36.9

The distribution of the egg production of the different breeds is shown in table 1. By referring to this table, it may be seen that, in general, the distribution of egg production during the year is fairly similar in all breeds, and that the trend followed very closely resembles that of the normal distribution curve as reported by Fronda in 1928[2].

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[2] Fronda, F. M. 1928. The seasonal distribution of egg production: The normal egg production curve. The Philippine Agriculturist **17**: 25-36. *Charts 1-2.*

Feed consumption. A total of 1,540.8 kilograms of grain and 1,458.7 kilograms of mash was actually used during the entire contest year. These amounts include the feeds consumed by the alternates. The feed consumption of the different pens, computed on the basis of ten birds, is given in table 2.

TABLE 2

Showing the amount of feeds consumed by each pen, computed on the basis of ten birds

ENTRY NO.	BREED	FEED CONSUMED		
		Grain	Mash	Total
		kgm.	*kgm.*	*kgm.*
1	S. C. White Leghorn[a]	171.5	171.3	342.8
2	Los Baños Cantonese	152.5	128.0	280.5
3	Los Baños Cantonese	139.6	131.4	271.8
4	Los Baños Cantonese	143.5	127.3	270.8
5	Nagoya	164.6	156.8	321.4
6	Mikawa	176.6	180.3	356.9
7	S. C. Rhode Island Red	197.1	187.6	384.7
8	Nagoya	154.1	147.5	301.6

[a] Only eight birds completed the year, but feed consumption was computed on the basis of ten birds.

By reference to table 2 it may be seen that in all of the pens, with the exception of the Mikawa pen, the consumption of grain was slightly more than that of the mash. It may also be seen from this table that the amounts of feed consumed by the three entries of Los Baños Cantonese fowls were fairly uniform.

When computed on the basis of feed consumption per bird according to breeds represented, it was observed that the S. C. Rhode Island Red fowls consumed the most, 38.47 kilograms of feed each. The Mikawa fowls consumed 35.69 kilograms each, the S. C. White Leghorns, 34.28 kilograms while the Nagoyas consumed 31.15 kilograms of feed each. The Los Baños Cantonese fowls consumed the least amount, only 27.43 kilograms for each bird.

Returns from the sale of eggs. In computing the income from the sale of eggs, the total pen production, including the "out" eggs, that is those that were laid outside of the trap nest, distributed on the basis of ten birds, was used. The total number of eggs thus produced by each pen, the percentage of eggs in each of the grades used in the contest with the total income derived from these are given in table 3.

TABLE 3

Showing the total pen production (including the "out" eggs), the distribution of these eggs according to size and the total income derived from the sale of the eggs

ENTRY NO.	BREED	TOTAL EGGS LAID[a]	SIZE DISTRIBUTION[b]			VALUE
			Extras	Standard	Undergrades	
1	S. C. White Leghorn[c]	1229	9.19	78.76	12.04	₱61.17
2	Los Baños Cantonese	1456	0	15.04	84.96	60.44
3	Los Baños Cantonese	1718	0	19.62	80.38	72.29
4	Los Baños Cantonese	1788	3.75	23.99	72.26	77.47
5	Nagoya	1495	8.29	73.98	17.73	73.64
6	Mikawa	1668	10.97	77.34	11.69	83.28
7	S. C. Rhode Island Red	1484	15.50	71.09	13.41	74.49
8	Nagoya	1578	4.25	76.30	19.45	76.73

[a] Including "out" eggs.

[b] Extras, 56 grams or over each.........₱0.72 a dozen
Standards, 45 to 55 grams each......... 0.60
Undergrades, 44 grams or less each...... 0.48

[c] Only eight birds completed the year. Computed on the basis of ten birds, this will be ₱76.46.

By reference to table 3, it may be seen that in spite of the fact that the Mikawa, Entry No. 6, occupied only the third place in the total number of eggs produced; in the total income from the sale of eggs, ₱83.28, it occupied the first place. The eggs of these birds are fairly large. Entry No. 4, Los Baños Cantonese, laid the largest number of eggs, but the eggs were rather small, so that the total income from the sale, ₱77.47, was not as large as that of the Mikawa breed. Entry No. 8, Nagoya, with ₱76.73, Entry No. 7, S. C. Rhode Island Red, with ₱74.49 and Entry No. 5, Nagoya, with ₱73.64 occupy the third, fourth and fifth places, respectively. The S. C. Rhode Island Red pen, Entry No. 7, laid the largest eggs, but laid an average of only 148.4 eggs each bird, as compared with the 166.8 eggs each in the Mikawa pen, Entry No. 6, the closest competitor of the S. C. Rhode Island Red pen in size of eggs.

According to the breeds represented, in the total income derived from the sale of market eggs, the Mikawa pen led with ₱83.28. The two pens of Nagoya fowls averaged ₱75.19 and occupied the second place, followed very closely by the S. C. Rhode Island Red pen with an income of ₱74.49. The three pens of Los Baños Cantonese fowls occupied the fourth place with an average income of ₱70.07. The S. C. White Leghorn pen brought in an income of only ₱61.17 during the year, but only eight pullets of this breed finished the year.

TABLE 4

Showing the cost of feeds consumed, the value of eggs produced and the returns above the cost of feeds

ENTRY NO.	BREED	COST OF FEED			VALUE OF EGGS	RETURNS ABOVE THE COST OF EGGS
		Grain	Mash	Total		
1	S. C. White Leghorn[a]	₱11.75	₱15.09	₱26.84	₱76.46	₱49.62
2	Los Baños Cantonese	10.40	11.28	21.72	60.44	38.72
3	Los Baños Cantonese	9.56	11.58	21.14	72.29	51.15
4	Los Baños Cantonese	9.83	11.21	21.04	77.47	56.43
5	Nagoya	11.27	13.81	25.08	73.64	48.56
6	Mikawa	12.10	15.86	27.96	83.28	55.32
7	S. C. Rhode Island Red	13.50	16.31	29.81	74.49	44.68
8	Nagoya	10.56	12.99	23.55	76.73	53.18

[a] Only eight birds completed the year, but computed on the basis of ten birds.

By referring to table 4, it may be seen that the cost of feeds per pen varied from ₱21.04, Los Baños Cantonese, Entry No. 4, to ₱29.81, S. C. Rhode Island Red, Entry No. 7. On the basis of breeds represented, the cost of feeds of the three Los Baños Cantonese entries averaged ₱21.30. This breed is the most economical of all the breeds represented, followed by the Nagoya, the average of the two pens entered being ₱24.32. The feeds consumed by the S. C. White Leghorn and the Mikawa entries cost about the same, ₱26.84 and ₱27.96, respectively. The most expensive breed, from the point of cost of feeds consumed, was the S. C. Rhode Island Red entry, ₱29.81 for the year. All of these figures are based on a pen of ten birds each.

Returns above the cost of feeds. By deducting the cost of feeds consumed during the year from the value of the eggs produced, including the "out" eggs, it may be observed, by referring to table 4, that the returns above the cost of feeds varied from ₱38.72, Los Baños Cantonese, Entry No. 2, to ₱56.43, Los Baños Cantonese, Entry No. 4. The Mikawa, Entry No. 6, followed a close second with ₱55.32 and Nagoya, Entry No. 8, occupied the third place with ₱53.18.

The returns above the cost of feeds of the three Los Baños Cantonese pens, Entries No. 2, 3 and 4 averaged ₱48.77 each, and the Nagoya pens, Entries No. 5 and 8, averaged ₱50.87 each. The returns above the cost of feeds of the other breeds represented in the contest, were as follows: Mikawa, one entry, ₱55.32, S. C. Rhode Island Red, one entry, ₱44.68; and S. C. White Leghorn, one entry, ₱38.72. If the cost of feeds represents 60.3 per cent of the total cost of production (Fronda and Paje, 1930)[3] the net income from these were as follows: Mikawa, ₱36.91, Nagoya, ₱34.87,

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[3] Fronda, F. M. and Pedro S. Paje. 1930. Factors in the cost of egg production. The Philippine Agriculturist **19**: 337-353. *Charts 1-4.*

Los Baños Cantonese, ₱34.75, S. C. Rhode Island Red, ₱25.05 and S. C. White Leghorn ₱31.95.

Mortality. Of the total of 103 birds entered in the contest, 14 died during the year, which represents a total contest mortality of 13.58 per cent. Of the 14 birds that died, 5 were S. C. White Leghorns, all from Entry No. 1, the pen that had the greatest mortality, 38.46 per cent. The long journey of this entry from British Columbia to the Philippines and changes of climate and feed were probably the real causes of the heavy mortality in this pen.

A surprise was sprung by Entry No. 6, Mikawa, a new breed recently introduced in this country, as none of the birds entered died during the year. Another pen, Entry No. 3, Los Baños Cantonese, also had no death. The other entries had mortalities ranging from 1, Entries No. 5 and 8, to 3, Entry No. 2. Entries No. 4 and 7 each had two birds that died during the year.

SUMMARY

The First Philippine Egg Laying Contest ended with the following important records:

1. Individual annual pullet production of 242 eggs, held by Nagoya, No. 421, Entry No. 8.
2. Five birds entered in this contest made a record of over 200 eggs each.
3. Pen annual pullet production of 1,643 eggs or an average of 164.3 eggs each bird, held by Los Baños Cantonese fowls, Entry No. 4.
4. The cost of feed consumed per pen varied from ₱21.04, Los Baños Cantonese, Entry No. 4 to ₱29.81, S. C. Rhode Island Red, Entry No. 7.
5. The feed consumption per bird, based upon the breed entered in the contest was as follows: Los Baños Cantonese, 27.43 kgm.; Nagoya, 31.15 kgm.; S. C. White Leghorn, 34.28 kgm.; Mikawa, 35.69 kgm.; and S. C. Rhode Island Red, 38.47 kgm.
6. The Mikawa pen, Entry No. 6, brought in the greatest returns from the sale of eggs.
7. The Los Baños Cantonese produced the smallest eggs and the S. C. Rhode Island Red produced the largest eggs.
8. The returns above the cost of feeds per pen varied from ₱38.72, Los Baños Cantonese, Entry No. 2 to ₱56.43, Los Baños Cantonese, Entry No. 4.
9. The mortality in the entire contest during the year was 13.58 per cent. Two pens, Los Baños Cantonese, Entry No. 3, and Mikawa, Entry No. 6, had no mortality.

AN IMPROVED SEEDLING VARIETY OF CHICO (ACHRAS ZAPOTA LINN. VAR. PONDEROSA.)[1]

L. G. GONZALEZ
Of the Department of Agronomy

WITH TWO TEXT FIGURES

In 1912 the College of Agriculture obtained a few seeds of chico from the botanical gardens at Buitenzorg, Java. This material was given the accession number C. A. 780. A number of plants were successfully grown from these seeds. Some were planted in the College grounds and a few were distributed to known individuals. From these seedlings there are only two plants that are now bearing. One, owned by Mr. Silvio Lopez is growing in his yard in the barrio of San Antonio, Los Baños, and bears fruits that are easily four to five times as large as the average native variety and is far superior in flavor and quality. It is so much larger and so much better in quality than the native variety that all who have seen it are amazed. Except for the size of the fruit, the other characteristics of the tree are similar to those of the ordinary native chico.

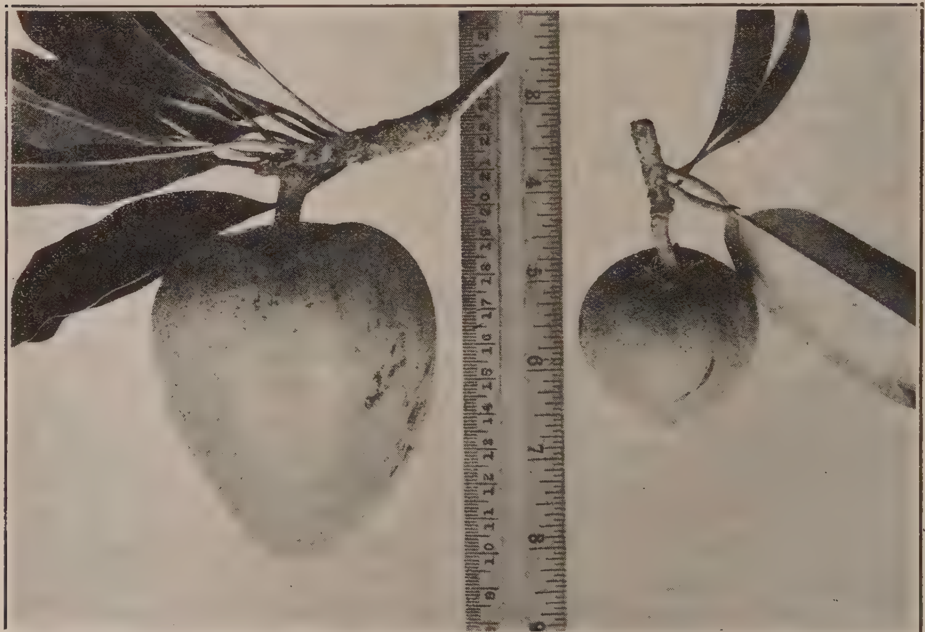

Fig. 1.—Fruits of chico (*Achras zapota* Linn.)
The fruit shown at the left is of the variety Ponderosa produced by the College of Agriculture. The one at the right is of the native variety. Note difference in size.

Because of the superiority of this variety of chico and since it lends itself very well to several methods of asexual propagation including marcottage, cleft and bark grafting, it is suggested that this variety be named *Achras zapota*, Linn. var. Ponderosa. The writer is convinced that the large size of the fruit is not due alone to a better physiological balance of the tree but is hereditary.

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[1] Experiment Station contribution No. 799. Received for publication, January 12, 1932.

A fuller description of the fruit based on the average of ten specimens picked at random follows: Weight, 348 grams (native variety, 77 grams); size, 9.6×8.2 cm. (native variety, 5.4×5.0 cm.); shape, oblong-ovate; length of stem, 2.2 cm.; stem, strongly attached to the fruit; sepals 6, persistent; color of the fruit, light brown with splashes of bronze; bloom, sparse; cavity, deep, abrupt; stigmatic point, prominent; flesh, light-pinkish cinnamon; texture, smooth, melting; grit, trace; fiber, inconspicuous; juiciness, juicy; flavor, vinous, very sweet; core, small, of same texture as flesh. Seeds, number, 1 to 6; size, 2.2×1.4 cm.; color black.

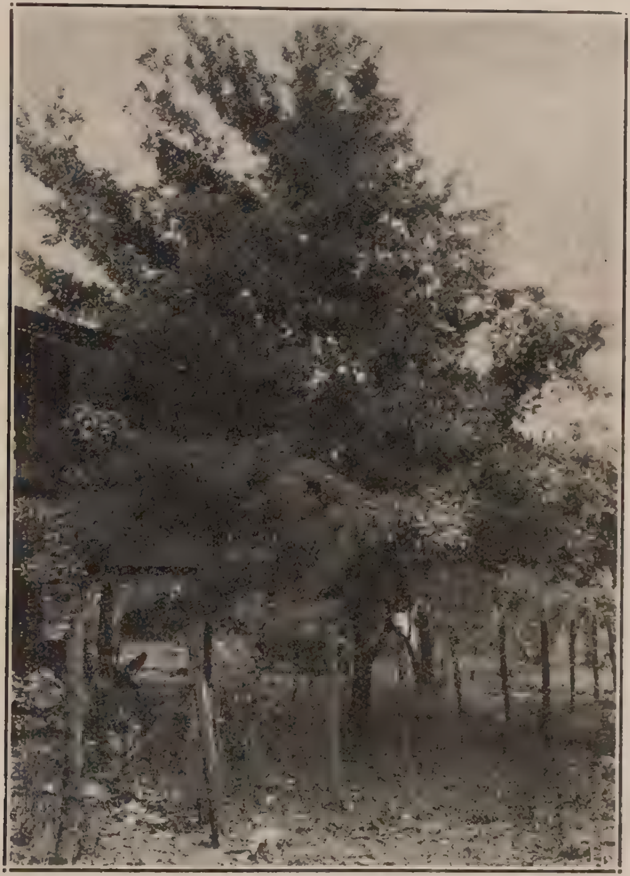

Fig. 2.—The original chico seedling variety Ponderosa. The tree has not been cultivated nor fertilized.

INFLUENCE OF DEPTH OF PREPARATION OF THE SOIL ON THE GROWTH AND DEVELOPMENT OF SUGAR CANE PLANT, VAR. LUZON WHITE, WITH SPECIAL REFERENCE TO THE YIELD OF ROOTS[1]

NUMERIANO L. CUEVAS

WITH THREE TEXT FIGURES

INTRODUCTION

The intimate relationship that, in general, exists between the top and the roots of plants is well recognized. It is known that the top is dependent for its activity and welfare upon the roots and the roots are dependent for certain things upon the top. With the sugar cane plant, however, most of the studies have been made on the aërial parts,—the leaves and the stalks. Studies on the roots of this important crop plant have been rather neglected.

Like the other parts of the sugar cane plant, the roots are rather plastic. Casual observation and the results of studies conducted in other countries show that the roots respond to the care or treatment given them. Recently, in the Philippines, Roxas and Villano (1930) report "that heavy root weights are correlated with heavy cane tonnage."

Previous literature on the subject

The literature on the root and the rôle that this organ plays in promoting the development of the plant body as a whole has recently been reviewed and summarized by Roxas and Villano (1930). In this review are found references to the work of Weaver (1919) on root development of plants in general. A review of these studies will not here be included. In discussing the results obtained from the present study, however, reference will be made, whenever possible, to the results from the studies of these investigators.

Studies on sugar cane roots have been reported by Wolters (1929), Weller (1928), Lee (1926), Venkatraman and Thomas (1929) and Lee and Bissinger (1928). The literature on sugar cane roots has also recently been reviewed and summarized by Roxas and Villano (1930). The studies of Wolters, Weller and of Venkatraman were made outside of the Philippines.

The two studies on sugar cane roots conducted in the Philippines were those of Lee and Bissinger (1928) and Roxas and Villano (1930). A review of these studies are here given.

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[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Agriculture, from the College of Agriculture No. 410, Experiment Station contribution No. 779. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

Believing that "a large part of the expense of producing a sugar cane crop is directed towards the development of the underground parts of the plant," Lee and Bissinger (1928) studied the distribution of sugar cane roots in the soil on the island of Luzon. From the data they obtained, these investigators found "there is a much larger proportion of roots in the topmost 8 inches of soil than in the lower depths of soil." They think this condition, "may possibly be ascribed to the compact nature of the soils in Calamba, which would lessen aëration to the lower levels of the soil and so probably lessen root formation in such lower levels." Moreover, they found the soil rather shallow with adobe rock subsoil. In Calamba, Lee and Bissinger found "in the topmost 8 inches the percentages of root distribution in the three excavations were 74.2, 78.3 and 71.2; in the levels from 8 to 16 inches in depth the percentages were 28.6, 17.2 and 22.9; in the levels from 16 to 24 inches in depth the percentages were 5.1, 4.5 and 5.9." From these results and from results of similar studies not here reviewed, Lee and Bissinger arrived at the conclusion that sugar cane growers are not concerned with the soil below the 24-inch level, but "are most concerned with the soil in the topmost 8 inches of soil."

Roxas and Villano's studies (1930) of the root and shoot development of the Mauritius-1900, an established variety of sugar cane at the experiment station in Canlubang, Laguna, brought out among other results the following conclusions:

> 1.—It was found that increased shoot development corresponded to increased root development, without exception.
>
> 2.—The roots of the cane develop faster than the shoot during the first months of its growth. This is in line with the old conception that plants first develop a good root system before shoot development will take place actively.
>
> 3.—Aëration of the subsoil favors the formation of greater masses of roots in the lower levels.
>
> 4.—The cane plant tends to concentrate its mass of roots within a zone about 5 inches on each side and 12 to 18 inches below the foot of the cane. This is the zone where fertilizer must be applied.
>
> 5.—Fertilizer increased the masses of roots through the whole system and not only in the zone where the fertilizer was applied.

Object of this study

Very limited studies have so far been made on sugar cane roots when grown under the soil and climatic conditions obtaining in the Philippines. Moreover, there is a lack of concrete knowledge on the influence of depths of preparation of soil for planting on the growth and development of the roots of this plant. For these reasons, this study was undertaken to determine the depths of preparation of soil best suited to the sugar cane plant in order to secure the best possible growth and development under Philippine conditions.

Time and place of this study

The present study, including the preparation of the plots, was conducted in the experimental plots of the Department of Plant Physiology, from March 19,1930 to January 2, 1931, a period covering ten months. The plants remained in the field, however, only for about eight months.

MATERIALS, METHOD AND RESULTS

Preparation of experimental plots

Forty-two experimental plots, each with an area of 1×1 meter were used in this study. They were about 30 centimeters apart. The soil was clay-loam and rather shallow, so that when the plots were dug up and the loose soil removed, the bottom and parts of the sides were adobe rock. Only the clay-loam soil was returned to the excavations; the adobe soil and other solid bodies were separated and discarded. Of course, care was taken that the soil taken from the different excavations was thoroughly mixed before it was returned to the excavations.

Six similar excavations were made, one, 5 cm. deep, one, 15, one, 30, one, 45, one, 60, one, 75. These excavations made on plots were used for the different culture types tested, and for convenience, were arbitrarily designated as culture types I, II, III, IV, V, VI, and VII. The six replications representing each depth of excavation were likewise arbitrarily labelled a, b, c, d, e, and f. These letter designations may be seen in tables 1[2], 2[2] and 4.

The "seeds", or cuttings

Ordinary "seeds", or cuttings of sugar cane var. Luzon White were gathered from a sugar cane field in Los Baños. These cuttings were cut into pieces containing one "eye", or bud each. These smaller cuttings were soaked in water for twenty-four hours and then planted in germinating boxes filled with sand. To hasten the sprouting of the buds, the boxes were covered with dried banana leaves and were watered from time to time. Seven days later, the buds had sufficiently sprouted to make it possible to select young shoots of apparently similar vigor, or state of development. The selected young plants were planted in the prepared plots on May 2, 1930, one cutting in the middle of every plot.

Care of cultures

Soon after planting, the plots were watered and each plant was sheltered from the heat of the sun with short pieces of fresh leaf sheaths of banana. Thereafter, water was sprinkled over the plots whenever it was needed. Weeding was done with a hoe or a spading fork. Incidentally, the plots were cultivated and the surface soil loosened. This care was given to the plants or the plots about twice a month or whenever weeds were becoming too abundant.

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[2] Owing to lack of space tables 1 and 2 are not published. They are filed in the Department of Plant Physiology.

Weather observations

During the experimental period, covering from May 2 to December 28, 1930, the weather was not especially variable. Light cloudiness of the sky prevailed almost throughout the entire growing period of the sugar cane plants. There were, however, some clear days especially in May, September and the latter part of August. The monthly rainfall varied from 231 to 477.2 millimeters. The least rainfall was in October and the greatest in November. Of the maximum temperature for each month was 31.5°C. in May, then it gradually went down to 29.1° in December. The minimum temperature for each month was 26.0°C. in May; went down to 25.5°C. in June; and went higher again to 26.1°C. in July. From 25.2°C. in August it rose gradually to 25.5°C. in November and then it fell again to 24.7°C. in December. The mean temperature ranged from 27.5 to 28.7°C. The humidity of the atmosphere varied from 55.5 to 66.0 per cent during the first four months (from May to August) and from 81.2 to 86.7 per cent, the

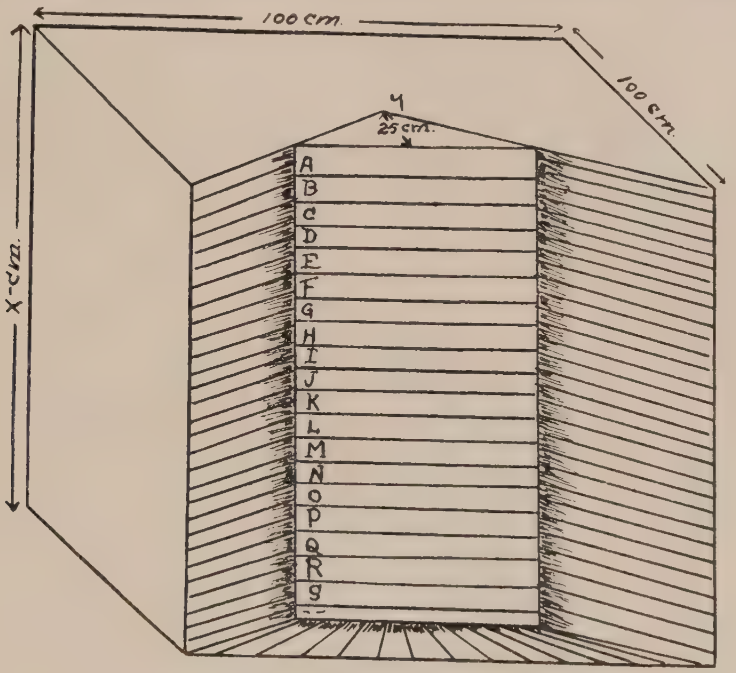

Fig. 1.—Showing the extent of excavation at the time counting of the roots was made (*Y*—center of the stool).

last four months (from September to December). Luckily, no typhoon occurred.

The harvest

On December 28, 1930, when the cane plants were about eight months old, the cultures were harvested. The stalks were cut at about the level of the ground and the fresh shoots obtained from each culture were weighed on a Toledo springless balance. The leaves were then separated from the stalks and the leafless stalks were weighed on the same balance. The data on the weights of the stalks obtained from the different cultures are recorded in table 1 (see footnote 2). Subtracting the weight of the stalks from the weight of the shoots obtained from each culture, the weight of the leaves from that culture was obtained. The data on the fresh weights of the leaves from the different cultures are shown also in table 1 (see footnote 2).

The roots, the most important subject of this study, were harvested. The roots were dug up in a manner similar to the method of excavation employed by Weaver (1919). A long but rather narrow trench was dug along one side of a row of cultures, fifty centimeters away from the center of the stools. The trench was dug as deep as there were sugar cane roots found in the soil. To widen the trench it was further dug towards the stools and at about 25 centimeters from the center of each stool (see fig. 1). The roots found in different zones or layers of the soil were counted. The zones

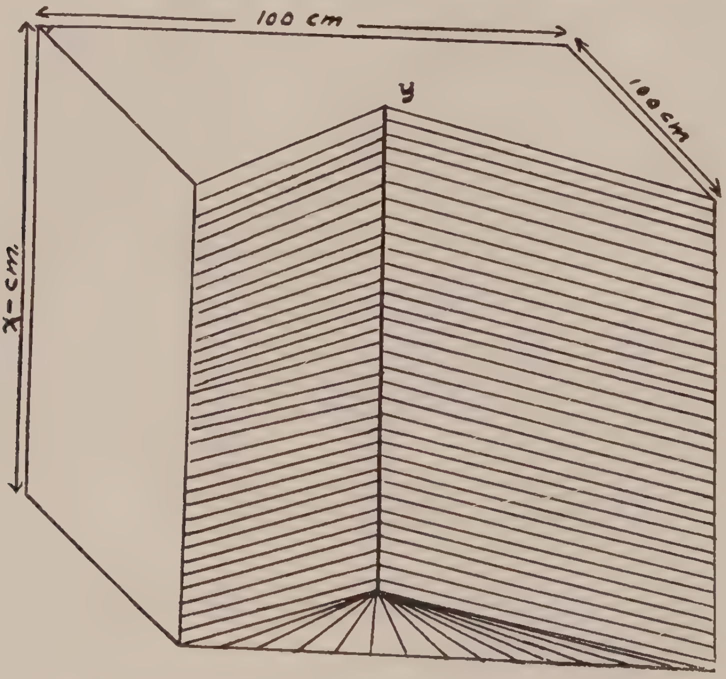

Fig. 2.—Showing the space from which the roots were taken.

were each 5 centimeters in width or thickness, running at right angles to the surface of the ground, and were 50 cm. in length. The data obtained from this observation are recorded in table 2.

All the roots that were dug up from the triangular space indicated in figure 2, or from one-fourth of the area of each plot were dried and afterward weighed. The amount of roots thus obtained represents only about one-fourth of the entire root system of each culture. The data on the dry weights of roots are presented also in table 1 (see footnote 1). A representative root system from each culture type studied was photographed (see fig. 3.)

DISCUSSION OF RESULTS

Influence of depth of preparation of soil on yield of stalks. Slight discrepancies exist in the data on the yield of stalks obtained from the six similar cultures under each culture type (table 1). The value of the results, however, may be appreciated when the averages are considered. The average data were recorded in table 1. But, to facilitate the comparison of the average figures, the average data contained in table 1 are summarized in table 3.

TABLE 3

Showing the average comparative weights of fresh tops and weights of dry roots of the sugar cane plants (Compiled from table 1)

CULTURE TYPES	DEPTH OF PREPARATION OF SOIL	WEIGHT OF FRESH STALKS	WEIGHT OF FRESH LEAVES	WEIGHT OF DRY ROOTS
	cm.	*kgm.*	*kgm.*	*grams*
I	5	0.44	0.53	28.6
II	15	1.19	1.16	56.7
III	30	2.75	2.55	88.4
IV	45	3.93	3.60	101.6
V	60	4.51	3.49	105.7
VI	75	3.47	2.65	90.7
VII	90	2.54	1.55	75.7

Examination of the data in table 3, shows that the yields of stalks were materially influenced by the depth of the preparation of the soil. As the depth was increased, there was a corresponding increase in the yield of stalks. The yield of stalks diminished, however, when the depth of preparation of the soil exceeded 60 centimeters. High yields of stalks were obtained from the culture types IV and V in which the depths of the preparation of the soil were 45 to 60 cm., respectively. The lowest yield was obtained from culture I in which the soil in the plot was dug or loosened to a depth of only 5 cm. Culture II, or the 15 cm. in depth, gave also a decidedly low yield of stalk. The actual yields of fresh stalks were, in kilograms, 0.44 for 5 cm. depth, 1.19 for 15 cm., 2.75 for 30 cm., 3.93 for 45 cm. and 4.51 for 60 cm. At 75 cm., the yield was 3.47 kgm. and at 90 cm., 2.54 kgm.

Influence of depth of preparation of soil on yield of leaves. The data in table 1 (see footnote 2) on the yield of leaves obtained from the six similar cultures grown under each culture type were also averaged. The average figures are shown in table 1, but for convenience of study, they are summarized in table 3.

Examination of the data under the criterion "fresh weight of leaves", shows that, like the yields of stalks, the yields of fresh leaves were materially influenced by the depth of the preparation of the soil in the plots. Decidedly low yields were obtained from the culture types I and II, in which the soil in the plots was dug up or loosened only to the depths of 5 and 15 centimeters, respectively. As the depth was increased, the yield of leaves also increased. However, beyond 60 cm. the yield of this plant diminished considerably. From table 3, it appears sufficiently established that the most favorable depths of loosening the soil in plots in connection with leaf yields were around 45 and 60 cm. At these two depths the yields of fresh leaves were 3.60 and 3.49 kgm., respectively. Whereas, from the cultures in which the soil was loosened only to the depths of 5 and 15 cm., the yield of leaves dropped to 0.53 and 1.16 kgm.

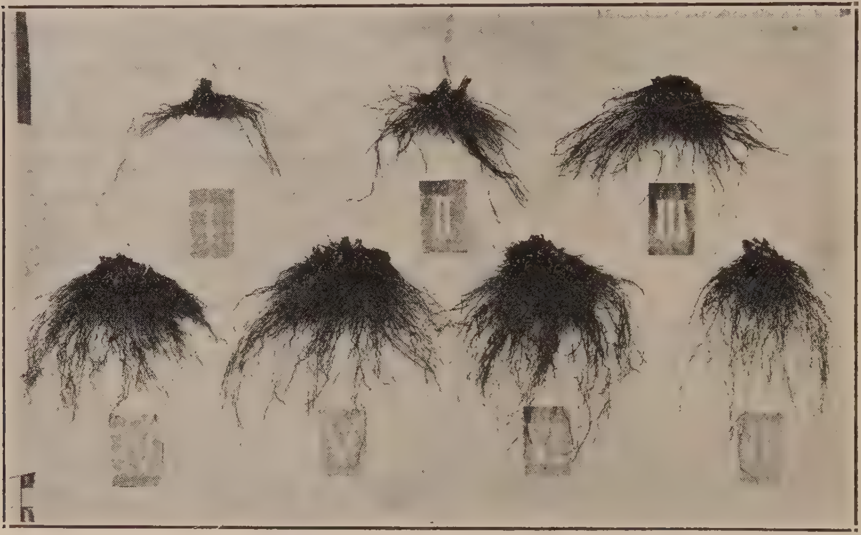

Fig. 3.—Showing the root system of sugar cane plants grown in plots each with soil prepared at different depth, from May 2, 1930 to December 28, 1930.

I. Planted in plot prepared 5 cm. deep.
II. Planted in plot prepared 10 cm. deep.
III. Planted in plot prepared 15 cm. deep.
IV. Planted in plot prepared 30 cm. deep.
V. Planted in plot prepared 45 cm. deep.
VI. Planted in plot prepared 60 cm. deep.
VII. Planted in plot prepared 75 cm. deep.

Influence of depth of preparation of soil on yield of roots. The data on the yields of roots were averaged (recorded in table 1). For convenience of study or of comparison, these averages are shown also in table 3.

By the data on "dry weight of roots" in table 3, it may be seen that the depths of preparation of the soil in plots materially influenced the growth and development of this underground part of the cane plant. The lowest yield, 28.6 grams was obtained from the shallowest depth tried, 5 cm. As the depths were increased, the root yields also increased. Beyond a depth of 60 cm., however, there was a fall in the yield of roots. The two most favorable depths of preparation of the soil appear to be 45 and 60 cm., from which cultures were obtained 101.6 and 105.7 grams of dry roots, respectively.

TABLE 4

Showing the total number of roots (computed) in each culture and in each vertical zone of 5 centimeters from the surface of the ground. (Computed from table 2)

CULTURE TYPES	DEPTH OF THE PREPARATION OF SOIL	REPLICATIONS						TOTAL NUMBER OF ROOTS IN SIX CULTURES	AVERAGE NUMBER OF ROOTS IN EACH CULTURE
		a	b	c	d	e	f		
	cm.								
I	5	20	19	19	55	43	47	203	34.0
II	15	24	36	32	48	63	72	275	45.8
III	30	90	83	71	125	141	122	632	105.3
IV	45	147	165	188	122	125	123	870	145.0
V	60	210	189	192	161	194	179	1125	187.5
VI	75	169	175	151	149	152	141	945	157.8
VII	90	161	150	150	160	156	162	930	155.0

The data in table 4, which were compiled from table 2 (see footnote 2), also show the influence of the depth of preparing the soil for planting upon the yield of roots. As the depth was increased the number of roots produced also increased. The data in table 4, show that the depth of loosening the soil most favorable for the production of the greatest number of roots, was 60 cm., or somewhere near this number. The total number of roots (computed) found in the different preparation depths were 34 and 45.8 for the 5 and 15 cm., respectively. From the 30, 45, and 60 cm. in depths, the number of roots were 105.3, 145.0 and 185.5, respectively, and the roots produced from the 75 and 95 cm. depths were 157.8 and 155.0, respectively. These figures are averages of six similar cultures.

Influence of depth of preparation of soil on distribution of roots in the soil. The data in table 2 show that the depths of preparation or loosening of soil in plots also materially influenced the distribution of roots in the soil. More roots were found in the deeper layers or zones in plots in which the soil was dug deep. As the depths decreased, fewer and fewer roots were found. These results seem to corroborate the findings of Roxas and Villano (1930) that aëration of the subsoil is favorable to the formation of more roots in the deeper layers of soil, and seem to suggest that deep plowing or cultivation might induce root formation in the deeper layers of the soil; while shallow plowing might retard root formation.

Computing and compiling the data on root distribution shown in table 2 (see footnote 2) on the basis of yield obtained from the six similar cultures, table 5 is here presented. In this table, it may again be clearly seen that the deeper the cultivation or loosening of the soil in the plots, the deeper were the roots found in the soil. The data in table 5 also show that roots exceeding 100 in number produced by the six similar cultures are found in culture type III within 15 cm. below the surface of the ground; those produced in culture type IV, within 20 cm.; those from culture type V, within 30 cm.; those from culture type VI, within 25 cm.; and culture type VII the roots exceeding 100 were found within 20 cm. of the surface of the ground. Basing judgment on the average of these figures, it is probably safe to conclude that the majority of the roots were found within 22 cm. below the surface of the ground. This result confirms Lee and Bissinger's (1928) findings. These investigators "found there is a much larger proportion of roots in the topmost 8 inches of soil, than in the lower depths of soil."

TABLE 5

Showing the total number of roots found within each 5-centimeter zone. (Data computed from table 2)[a]

ZONES 5 CM. EACH	CULTURE TYPES						
	I	II	III	IV	V	VI	VII
A	94	74	104	132	146	99	115
B	65	82	110	167	129	119	125
C	25	59	129	142	186	137	144
D	13	28	89	124	125	113	117
E	14	11	74	92	120	105	80
F	1	10	76	75	103	83	66
G	1	3	28	53	90	66	50
H		5	13	36	72	51	42
I		3	6	33	71	36	35
J			2	14	43	37	34
K			1	6	18	29	26
L				4	10	18	20
M				3	8	19	15
N					4	14	12
O					0	10	10
P						7	12
Q						4	7
R							9
S							9
T							2

[a] The number of roots per zone in each of the culture types is the total of all the roots found per zone in 6 replications.

Roxas and Villano (1930) report that the "cane plant tends to concentrate its mass of roots within a zone about 5 inches on each side and 12 to 18 inches below the foot of the cane."

Yield of tops and yield of roots compared. Examination of the data in table 3, shows that the production of roots was, in some degree, proportionally correlated with the yield of tops. An increase in the yield of roots was accompanied by a similar increase in the yield of fresh stalks and of fresh leaves of the cane plant. The two highest root values (in table 3) produced by the culture types IV and V were accompanied by the two highest yields of fresh stalks and of fresh leaves of all the cultures tested simultaneously. It is, therefore, quite evident that the results referred to above corroborate the conclusion drawn by Roxas and Villano (1930), from their review of the literature on the roots of the cane plants, to the effect that it is "a definite conclusion that heavy root weights are correlated with heavy cane tonnage."

SUMMARY AND CONCLUSIONS

1. A comparative study of the influence of different depths of preparing the soil in plots on the growth of sugar cane plant with special reference to the yield of roots was made.
2. As the depth of preparing the soil was increased, a corresponding increase in the yield of stalks of sugar cane plants was obtained. At depths exceeding sixty centimeters, however, the yields of stalks diminished.
3. The yields of leaves of sugar cane plants increased as the depths of preparation of the soil for planting were also increased. Depths beyond sixty centimeters produced diminished yields of leaves.
4. The yields of roots were also increased as the depths of preparing the soil were increased up to sixty centimeters; beyond this depth the yields of roots decreased.
5. The deeper the preparation or loosening of the soil, the greater the number of the roots and the deeper were the roots of sugar cane found in the soil.
6. By a rough estimate, the majority of the roots were found within twenty-two centimeters below the surface of the ground—confirming Lee and Bissinger's (1928) findings.
7. The yield of roots was found to be proportional to the yield of tops, corroborating the conclusion arrived at by Roxas and Villano (1930) to the effect "that heavy root weights are correlated with heavy cane tonnage."

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ABSTRACT[1]

A study of the cost of production and marketing of tomatoes in San Carlos, Pangasinan. Francisco O. Manzon. (*Thesis presented for graduation, 1931, with the degree of Bachelor of Agriculture from the College of Agriculture No. 411; Experiment Station contribution No. 780*).—From data collected in five investigations made at different seasons of the year the author wrote a report on: (1) cost of production of tomatoes; (2) marketing and marketing costs; (3) distribution of income. The survey covered 100 farmers. The data were obtained by personal interviews facilitated by issuing a set of questionnaires. The work on cost of production was carried out in San Carlos, Pangasinan, and the methods and costs of marketing were studied in the same town and in Manila, the principal consuming market for tomatoes.

The results of the study follow:

Of the 100 farmers studied, 74 were owners; 18 were share tenants; and 8 were cash tenants.

The items of cost considered in the survey were: (*a*) land cost, (*b*) labor cost, (*c*) implement cost, (*d*) cost of seed, (*e*) cost of marketing borne by the farmers, (*f*) interest on the capital invested.

The average cost of production per hectare was as follows: ₱74.18 for owners; ₱119.17 for share tenants; and ₱69.58 for cash tenants. The average for all farmers was ₱80.28.

The average cost of production per *kaeng* (48 kgm. of tomatoes) was ₱1.49 for owners; ₱2.00 for share tenants; and ₱1.23 for cash tenants. Disregarding tenure, the average cost of production per *kaeng* was ₱1.55.

The average gross income per hectare was as follows: ₱109.80 for owners; ₱128.00 for share tenants; and ₱116.00 for cash tenants. The average gross income per hectare for all farmers disregarding tenure was ₱113.13.

The average net income per hectare was as follows: ₱35.62 for owners; ₱8.83 for share tenants; and ₱46.90 for cash tenants. The average net income per hectare for farmers in all tenures was ₱32.84.

Share tenants had the highest average gross income per hectare but they had the lowest average cost of production per hectare. The cash tenants had the highest average net income per hectare because they had the lowest average cost of production per hectare.

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[1] Abstract prepared as part of required work in English 3a, College of Agriculture.

The product was not sorted or graded by either farmers or dealers.

There were two terms of sale, by cash, the most common, and by contract. When the product was sold locally it was hauled in carretons but when sold in Manila it was shipped by railroad.

Marketing costs involved the farmers' costs and the middlemen's costs. The farmers' costs consisted of the hauling cost and interest and the middlemen's included (1) the hauling cost from local buyers to the shipping point, (2) freight cost, (3) hauling cost from terminal point to the middlemen's warehouse, (4) cost of *kaeng*, (5) interest on the capital invested, (6) internal revenue tax, (7) loss through spoilage in transit and storage and (8) the miscellaneous expense such as the cost of covers of *kaengs* and of tags and wire.

The average price received by farmers in San Carlos for one *kaeng* of tomatoes was ₱2.18 which was 41 per cent of the wholesale price in Manila.

The total marketing costs of middlemen per *kaeng* was ₱0.995 composed of the following items: hauling to shipping point at San Carlos, ₱0.10; railway freight charges, ₱0.49; hauling to buyer's storage, ₱0.15; interest on capital invested, ₱0.006; tax, ₱0.047; loss through spoilage, ₱0.039; cost of container, ₱0.133; miscellaneous, ₱0.026. "The profit of middlemen per *kaeng* was ₱2.13. The margin of middlemen or the difference between farmer's selling price and wholesale price in Manila was ₱3.125, or approximately 59 per cent of the wholesale price. Of this margin, 19 per cent was marketing costs and 40 per cent, profit of the middlemen".

The income was distributed to the farmer, to the transportation agents, and to the middlemen. The income of the farmer was distributed to land, as land cost or rent, to capital as interest and to labor as wages and to himself as net income.

The results obtained may be summarized as follows:

(1) The major portion of the tomatoes produced in San Carlos are shipped to Manila.

(2) The average cost of production per hectare for all farms, disregarding tenure, was ₱80.28. The cost of production per hectare of owner farmers was ₱74.18; share tenants, ₱119.17; and cash tenants, ₱69.58.

(3) The average cost of production per *kaeng* for all farmers, disregarding tenure, was ₱1.55. The cost of production per *kaeng* of owner farmers was ₱1.49; of share tenants, ₱2.00; of cash tenants, ₱1.23.

(4) The average price received by farmers in San Carlos per *kaeng* of tomatoes was ₱2.18 which was 41 per cent of the wholesale price in Manila.

(5) "The profit of middlemen per *kaeng* was ₱2.13. The margin of middlemen or the difference between farmer's selling price

and wholesale price at Manila was ₱3.125, or approximately 59 per cent of the wholesale price. Of this margin, 19 per cent was marketing costs, and 40 per cent, profit of the middlemen".

(6) The average gross income per hectare for all farmers, disregarding tenure, was ₱113.12. The gross income per hectare of owner farmers was ₱109.80; of share tenants, ₱128.00; of cash tenants, ₱116.48.

(7) The average net income per hectare for all farmers under all tenures was 32.84. Owner farmers had an average net income of ₱35.62 per hectare; share tenants, ₱8.83; cash tenants, ₱46.90.

(8) The income from tomato production is distributed to the farmers, to transportation agents and to middlemen. The farmers' gross income is distributed as follows: (*a*) One-half of the gross income to labor cost, (*b*) one-seventh to land cost, (*c*) one-twenty-ninth to capital cost, (*d*) over one-third of the gross income is the net income of the farmer.

—*Abstract by Marcos A. Vega.*

EXCHANGE NOTES

It may be interesting to note that in the Philippines the area under bananas has increased from 208 015 acres in 1921, to 271,072 acres in 1929 [from *Philippine Journal of Agriculture*]. The increase of area has not been attended however, with any proportionate increase in production. So far no attempt has been made to produce a surplus for export. The plantings are mainly within small yards and about dwellings to supply the demand of the homes. The article from which we quote identifies no fewer than 17 varieties; and it is a thought that must have occurred to many growers that the few varieties in cultivation in Australia might very possibly be increased in number with distinct advantage to the industry. In the matter of cultivation, it may be noted that the Philippine writers lay special stress upon the care which should be exercised in the removal of superfluous suckers, so that neither the parent plant nor the remaining suckers shall be injured. "All suckers are actually fed by the parent plants," it is pointed out, "until they are large enough and have produced sufficient roots to survive independently. . . .

Under the heading "General Uses of Philippines Bananas", no fewer than 12 varieties are listed as best for dessert; and only five for cooking. Another classification is—"Trunk suitable for hog feeding," under which are three varieties; whilst five are regarded as suitable for making dried "figs"; six for making banana flour; four for vinegar making; four as suitable for jam, and three for flavouring meat. In each case these are mentioned by their native names, the only one identifiable with a variety grown here being "Tampohin"—the name under which Cavendish is there known; but from descriptions and photographs it is evident that great differences exist between the different varieties grown.

—*The Australian Sugar Journal*, October 8, 1931.

In these last five years the use of fertilizer nitrogen in the United States has increased about 50 per cent, while production has increased 100 per cent. American production of synthetic nitrogen from the air has increased 1000 per cent. . . .

—*Review of Reviews,* August, 1931.

A group of fifty Genesee County farmers up here in Western New York have started an innovation which it seems to me is destined to spread to other farms all over America. Genesee farmers have made up a pool—not of commodities, in an effort to bull the market and cut down sales cost, but a pool of that more intangible though no less valuable asset known as farm experience.

Graded and packed, and certified by experts over at Cornell University, the experience of every man on every enterprise on his farm goes down in black and white and is made available to every other man in the group.

Each contributor not only gets back forty-nine other contributions, but gets the whole picture-giving analysis of the fifty farms of the group. These Genesee farmers are in effect putting the meter on leaks and on earnings, enterprise by enterprise, and method by method. Since this scheme has been in effect, losing ventures and wasteful methods have been rogued out to an unheard-of degree. Today Genesee farm enterprises and methods of conducting them are rapidly being standardized on the basis of the best that anybody in the community has developed. . .

The plan begins with farm cost accounting, but this is something far more than a simple cash account record. . . .

Every enterprise on these farms has come under scrutiny as never before, and momentous changes are being made in choice of crops. Mixed hay or timothy alone has been in the red ink on almost every farm. The few men who have specialized on alfalfa have made an excellent showing. The small grains, particularly wheat, on farm after farm have been shown to yield far less than nothing for the hours of labor wasted in their culture. Corn for grain has also come under the ban. . . .

The accounting system in vogue—it was inaugurated and is supervised by extension workers from the Economics Division at Cornell—is so simple and easily understood that on every farm of the group the basic records are kept by the farmers themselves. Each farm chips in a fee of some thirty dollars a year to pay an expert who goes around once a month and posts the books, and who also makes summation studies at the end of the year.

—*The Country Gentleman*, July, 1931.

One vegetable much pushed by the seed department of this Society, we have failed to make popular, although in our opinion, and that of a few who have tried it, is superior to turnip and cabbage, and that is Kohl-Rabi, originally a German introduction and supposed to be a cross between turnip and cabbage, at any rate the flavour is a mixture of both. It is hardy, grows quickly, can be used young, is cooked like turnip. The growth is like a cabbage when young but it bears a round ball in the heart of the beans; there are two varieties, green and purple. It also grows during the summer in the lowlands, when cabbages will not head. Please try it.

—*The Journal of the Jamaica Agricultural Society*, July, 1931.

COLLEGE AND ALUMNI NOTES

Father Casey, priest at the College Catholic Church, gave an address on the evening of November 22 in the College Auditorium. The principal theme of the interesting address was distinguishing between the French Revolution and the American Revolution as to causes, results and characteristics of leaders of thoughts.

Dean Gonzalez received a letter from Prof. L. R. Jones written on board *President Lincoln* under date December 1. The following excerpt from the letter is highly gratifying to the faculty and students, as well as to Dean Gonzalez:

> As Mrs. Jones and I journey northward we continue to look back upon our days at Los Baños as among the pleasantest of all in our travels. Nowhere else do I know an Agricultural College more richly environed—with your charming lake in the fore and backed upon the slopes of Makiling. And your faculty seem men of excellent ability and training working with harmony and efficiency. I am sure you are to be congratulated upon these evidences of sound administrative leadership. And in addition to the fine educational program the research output including that of your own department was most encouraging. The organization of your scientific men seems asseverance that this is to progress with increasing vigor.
>
> Will you please assure the representatives of the societies who so kindly welcomed and entertained us of our high appreciation of their courtesies. . . .

The well-known Limjap family of Manila were visitors on the Campus on Sunday, December 6, 1931. The party consisted of Mrs. Mariano Limjap, Dr. and Mrs. A. R. Ubaldo, Mrs. Sergio Osmeña, Mr. José Limjap, Mr. and Mrs. R. B. Santos, Mr. Francisco Limjap, Representative and Mrs. Boncan, Mr. and Mrs. Santos, and Dr. and Mrs. Gabino.

Mothers' Day was observed by a program in the evening in the College Protestant Chapel. The service opened with the beautiful candle-lighting ceremony, during which "Little Mother of Mine" was played softly on the violin and organ. A simple impressive play "Mother's Dream" was presented. The atmosphere, the setting, the program all made the celebration of this Day most appealing.

The Los Baños Biological Club held its monthly meeting on Friday, November 13, 1931, at 8:00 p. m. in the Lecture Hall of the Department of Agricultural Chemistry of the College of Agriculture, Los Baños, Laguna. The program follows:

1. "*Gumaan* driftwood (Cavanillesia)."
   —By Mr. Luis J. Reyes, Chief, Division of Forest Products, Bureau of Forestry.
2. "The amino-acids content of kandule (*Arius* spp.)"
   —By Dr. F. O. Santos and Mr. N. L. Galvez. Paper read by Mr. Galvez.
3. Introduction of the Guest of Honor, Dr. L. R. Jones.
   —By Dean B. M. Gonzalez.
4. Address, by Dr. L. R. Jones, Head, Department of Plant Pathology, University of Wisconsin.

Domingo J. Cayabyab, B. Agr. '29, writes Doctor Fronda that he is now Rural Credit Agent under Rural Economics Division, Bureau of Plant Industry. He is located at Cagayan, Oriental Misamis. Before he received this appointment he worked for the American Red Cross Society as agriculturist in the Visayan Islands.

On the evening of November 25, 1931, the U. P. Rural High School under the Department of Agricultural Education presented in the Auditorium a two-act operetta, "The Toreadors", with the following cast of characters:

Señor Dictorio,	Wealthy Farmer, Admirer of Toreadors	Antonio Ocampo
Benita	His twin daughters	Simplicia Tamban
Juanita		Virginia Mondoñedo
Juan	Sons of Neighboring Farmers and admirers of Benita and Juanita	Hilario Santos
Pablo		Arcadio Monzon
Señor Swateo	Beggars masquerading as Toreadors	Romeo Espino
Señor Whackeo		Isagani Mariano
Dolores	Friends of Juanita and Benita	Salud Lawas
Maria		Teofista Ocampo

The Chorus celebrating Benita's and Juanita's birthday

Girls	*Boys*
Lucia Cleto, Dancer	Gregorio Aliga, Dancer

Irenea Erasga
Maria Lawas
Eutemia San Luis
Isabel Maniñgas

Zósimo Almeda
Felix Apigo
Fidelio Gregorio
Eulalio Palis
Francisco Palis
Quiterio Villarino

The operetta, the first of its kind to be presented on the Campus, consists of twenty-four musical numbers, several Spanish dances, and an exciting plot. How the two heroes, Juan and Pablo, succeeded in carrying out their plan of disguising two beggars as Toreadors in order to teach Señor Dictorio a lesson, made an evening of lively entertainment.

The excellent character work of Antonio Ocampo, the sincere work of all the principal characters, the spirited music of the chorus, the artistic costumes, and the enthusiastic audience, made the musical comedy a success.

Miss Hazel D. Reed, who directed the operetta, deserves much praise for her very able work. Mrs. Hugh Bousman accompanied the songs with her usual sympathy and musicianship. Credit also belongs to Mrs. Helen Foster who supervised the making of the costumes.

* * *

At an election held by the Rancher's Club on October 28, 1931, the following officers for the second semester were elected:

Governor	Felicisimo D. Suratos (re-elected)
Lieutenant Governor	Dominador Clemente
Secretary	Dennis Molintas (Appointed)
Treasurer	Gregorio Chan
Sheriff	Felicisimo Maceda
Adviser	Dr. Miguel Manresa

The governor appointed the following councilors:

Cattle	Luis Alder
Horses	Alberto Elefaño
Swine	Miguel Alba
Poultry	Alfredo A. Francisco
Sheep and Goats	Gavino Arriola
Dairy	Cecilio Antonio

* * *

Gray Star, son of Hassan, the College stud-horse that recently died, has won new laurels on the race track at the San Lazaro Hippodrome, Manila. He made first place in a race on Thanksgiving Day and again on December 6 he left all competitors behind.

COÖPERATIVE MARKETING

(Extracts from an address on "Agriculture as a Vocation" by Alexander Legge, President, International Harvester Company, at University of Wisconsin College of Agriculture, Madison, Wisconsin, May 20, 1931.)

. . . . Production is only half the battle. In farming, as in any other industry, good marketing is as important as in good manufacturing.

Consciously or unconsciously, I think we have overstressed production in all our efforts to improve agriculture in the past—yes, even in the education of our agricultural colleges. . . .

Coming to the twofold question of production and marketing, it hardly seems necessary to argue in support of the statement that nothing is gained by producing any commodity that must be sold at a loss. . . .

In the past the efforts of farmers to improve their situation without having a full and up-to-date knowledge of all the elements and factors involved have been successful in too small a percentage of cases. . . . The whole situation calls for specialized training and such information as you students in the agricultural colleges are acquiring in your studies. . . .

Business men now engaged in the handling of farm products resent the coming of the coöperatives as a reflection on their efficiency. In so doing they lose sight of the far broader aspect of the case; that is, the possibilities of what can be accomplished through collective action as compared with the individual private trader.

Take, for illustration, what is commonly called trade promotion—that is, the development of broader and better markets—one of the fruit coöperatives is spending two million dollars in advertising this present season. How could anything of that kind be accomplished through the old methods of merchandising? The individual producer could not afford to spend money which would equally benefit all other producers, even though they did not share in the expense. The individual merchant handling the commodity could not afford to spend money that would benefit his competitors as much as himself. Collectively, the producers of the commodity can do this successfully, without undue burden for any one of them and with equal benefit for them all.

Therefore, regardless of all of the opposition and regardless of all of the unfortunate mistakes the agricultural groups make in taking on this class of work, in my judgment the coöperative marketing movement is going

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to grow, but it will require men of special education and training to handle these operations successfully. . . .

It is true that the graduates of the colleges would be better fitted for taking on these duties if they could have the benefit of an apprenticeship to give them a little more actual commercial experience before undertaking the work, but as compared with the average man who is usually selected to handle such a job, the college training that you are getting will start you off with a far better chance of success. . . .

In choosing one's vocation in life, the factor of stability is vitally important. Within the lifetime of most of you the blacksmith shop and the horseshoer and the liveryman have disappeared, to be replaced by the garage. . . . There are fewer hazards of this kind in the agricultural field than in any other occupation. . . .

Taking a long and conservative look ahead, I can see some important changes coming in the picture of our agriculture, and they are all changes for the better. Coöperative marketing is not a mere theory; it is a condition, a substantial fact. I believe that it will grow in importance and influence and that it will have vital effects in helping the farmer to put himself on a footing that will compare favorably with other industries.

Not only will the replacement of individual marketing by collective marketing affect the bargaining of agriculture in marketing its products, but it is bound to affect the quality and the uniformity as well as the quantity of farm production. That has been the experience of all the successful coöperatives in the past, and there is no reason why the same system applied to other products including our major staples, should not have the same results.

There may and probably will be important agricultural production changes with respect to size of farms, because today one of the frequent causes of agricultural inefficiency is that the individual producer does not grow enough of a certain commodity to get satisfactory production costs; and on the other hand many producers are found to be not only growing more of this or that commodity than is called for by a properly balanced production program but also more than the character of their land warrants.

One of the most encouraging signs that I have noted in my contacts with the 4-H Club movement is the number and kind of young women who are earnestly and seriously striving toward improvement in the things that go to make up successful home management, whether that home is to be on the farm or in town. I am told that there are a very substantial number of young women here in your agricultural college studying home economics. More power to them—and may more and more young women follow their choice of vocation and qualify themselves for partnership in the agriculture that centers around the farm home.

TWO RUSTS ON WRIGHTIA LANITI (BLCO.) MERR.[1]

F. L. STEVENS
Charles Fuller Baker Memorial Professor of Plant Pathology (1930-1931)

WITH FOUR TEXT FIGURES

AECIDIUM PROLIXUM SYDOW ON WRIGHTIA LANITI

This aecidium was described by H. Sydow in *Annales Mycologici* vol. 19, p. 304, 1921. It causes a conspicuous and destructive witches' broom often killing many branches of considerable size (fig. 1 and 2). The fungus

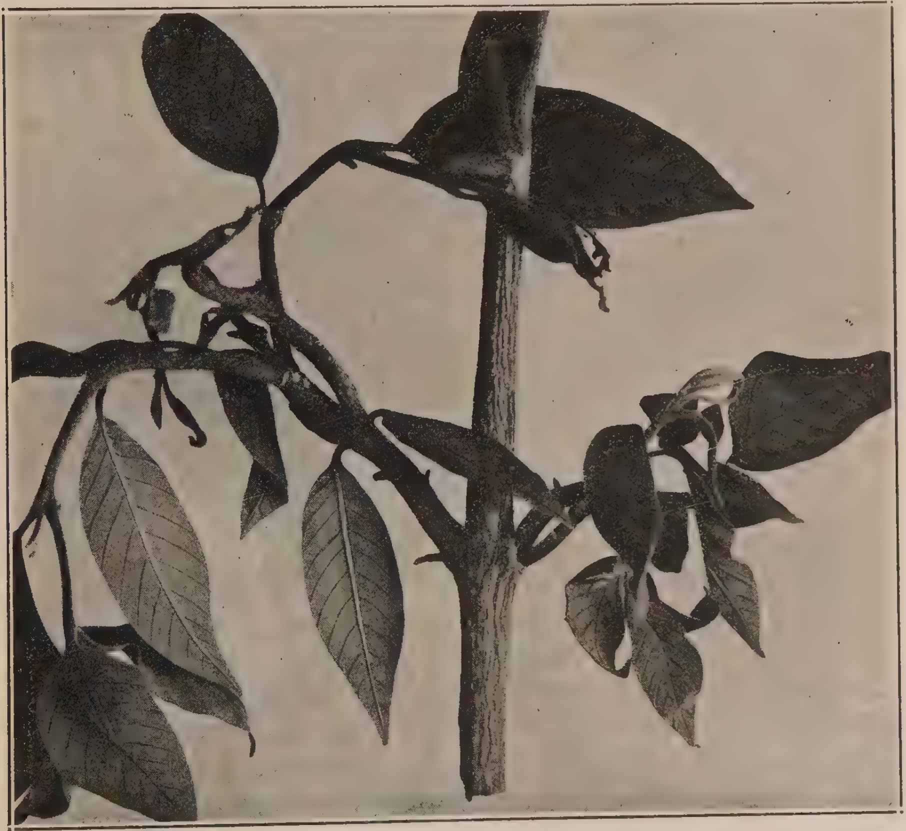

Fig. 1.—*Aecidium prolixum*, a young witches' broom showing the hypertrophied twig. Infection is from within. These are covered with pycnia and aecia are beginning to appear. (All photographs by Photographic Division, College of Agriculture.)

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[1] Experiment Station contribution No. 789. Received for publication December 18, 1931.

is perennial within the host and all buds and lateral branches from a diseased shoot are infected throughout with very excessive hypertrophy (fig. 2). In the young stage the diseased surface bears very numerous pycnia and soon afterward numerous aecia both on the twigs and the young leaves. These are the typically cup shape and are surrounded by a much protruding strongly lacerate white peridium which is cut into from two to six strips some 600 μ long. The aecia on green twigs are scattered, usually a millimeter apart.

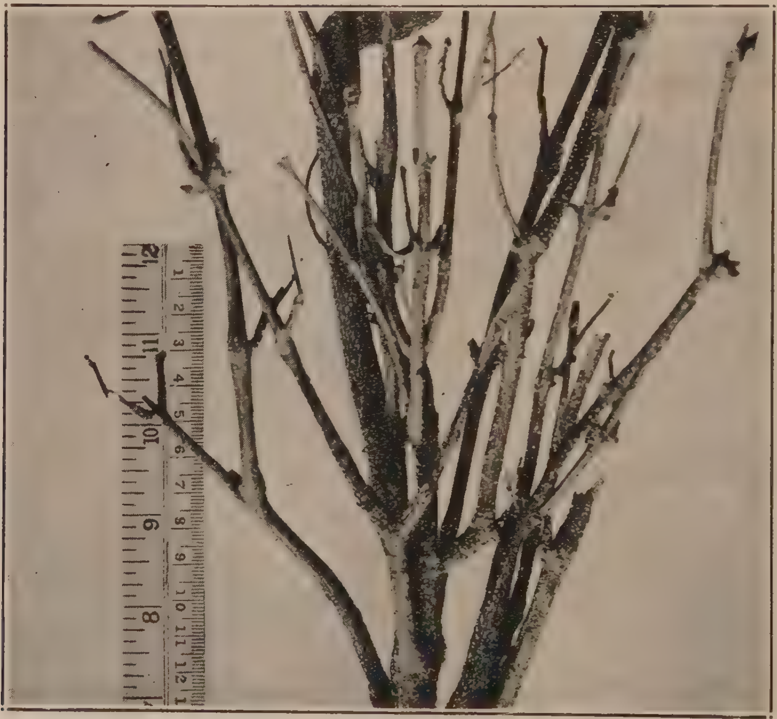

Fig. 2.—*Aecidium prolixum*, an old witches' broom.

The peridial cells are hyaline, irregularly oblong; surface rough, 21-31×17-20 μ. The aeciospores are subglobose or angular, minutely rough, 24 to 28 μ, protoplasmic content yellowish, wall thick, 3-5 μ.

The twig continues to grow and adventitious buds develop below it giving the witches' broom effect. The twigs live for considerable time but eventually die still showing the scars of the aecia and holding yet a few viable spores. Sowing of the aeciospores by natural dropping from caulicolous aecia on agar gave practically 100 per cent germination of long germ tubes in 15 hours. Spores on bare glass did not germinate.

HEMILEIA WRIGHTIAE RAC.

(Including record of an aecial stage for *Hemileia*)

Upon the same trees that bore the *Aecidium prolixum* described above were leaves affected by a rust which was at first assumed to be stages of *Aecidium prolixum* but which on further study proved to be *Hemileia wrightiae.* The rust occurred in two forms which may be described from our specimens as follows:

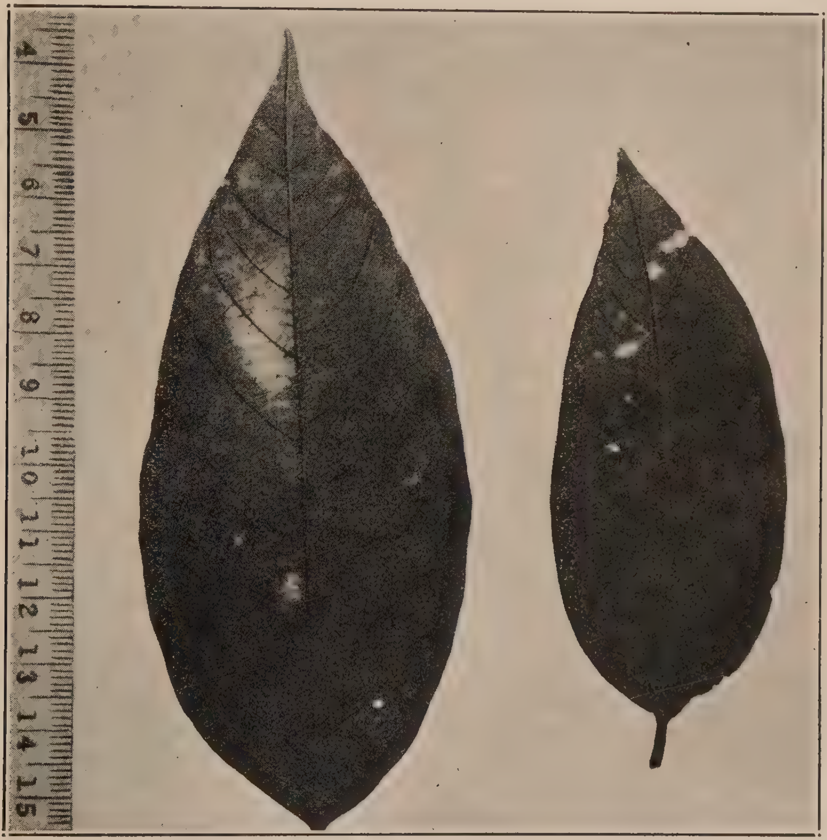

Fig. 3.—*Hemileia wrightiae;* smaller leaf showing the definite form of the spot, aecidial, with spores that germinate as in figure 4a; larger leaf the indefinite, with spores that germinate as in figure 4b, c.

A. Spots, as seen from above, small, 1-3 mm. pale, slightly sunken, with a *very definite* border. Viewed from below these are seen to bear aeciospores in bright red sori (fig. 3, right.).

The spores are sub-globose oval or irregular, slightly rough, and 14-21 × 24-28 μ, bright red when fresh.

Germination in hanging drop is by a thick, 7-11 μ, unbranched germ tube with red protoplasmic content (fig. 4 a).

B. The other form of spore occurs upon the same trees and it may be described as follows:

Seen from above it consists of a broad diffuse spot with no definite shape or definite border and which may cover the whole leaf. Instead of being distinctly pale as in the one described above it is yellowish. This spot on the lower surface bears spores over its whole surface and they are of a decidedly more pale reddish hue than those of the form described above. The difference between these two spots is shown in figure 3.

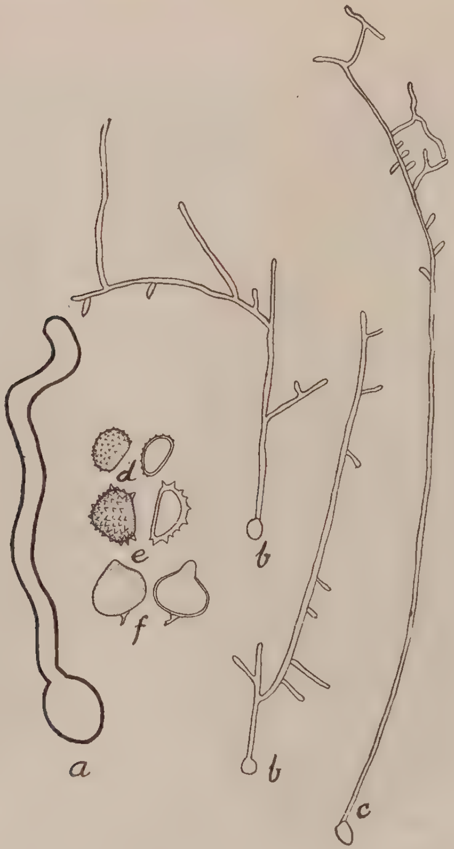

Fig. 4.—*Hemileia wrightiae* (*a*) germination of the aeciospore; (*b*) germination of the urediniospores, as in water; (*c*) as extending into air; (*d*) spores, stage I; e, stage II; f, stage III.

The spores of the form described above under *B* are similar to those of *A*, but are more irregular in shape and bear distinctly larger spines.

The form *B* germinates very rapidly and abundantly on wet agar or in hanging drop producing a profusely branched colorless germ tube, (fig. 4 b, c), which is quite uniformly 4 μ thick. When the germ tube reaches into the air it is for long unbranched and empty of protoplasm below, then bears numerous branches (fig. 4 c).

It is thus seen that the two forms differ as to spore, spines, color, leaf spot, germination, germ tube size, branching and color. It has been suggested by Dr. J. C. Arthur of Purdue University that the former of the two spore stages described above under *A*, represents an aecial stage of the *Hemileia* and the first aecial stage recorded for this genus, that this "is undoubtedly a uredinoid aecium".

It is much to be regretted that this aecial stage was very rare, repeated attempts to collect it resulting in only a few leaves.

The following description and comments are added by Doctor Arthur:

Hemileia wrightiae Rac.; Sydow, Monog. Ured. **1**: 218. 1914. *Hemileiopsis wrightiae* Rac., Parasit. Alg. u. Pilze Javas, pt. 1, p. 26, 1900.

Pycnia not seen.

Aecia, uredinia and telia hypophyllous, from fascicled hyphae protruding through the stomata. Aeciospores obovoid or kidney-shape, somewhat flattened on one side, 13-16 by 17-23 μ; wall colorless, uniformly 1-1.5 μ thick, strongly echinulate, except smooth on flattened side. Uredinospores same shape as aeciospores, but somewhat triangular, 13-19 by 19-26 μ; wall colorless 2-3 μ thick, thinner on flattened side, 1.5 μ, coarsely aculeate on convex side, with spines 4 μ high and 3 μ wide at base, smooth on flat side. Teliospores globoid or napiform, with apical protuberance, 19-26 by 23-32 μ; wall colorless, 1 μ thick, smooth.

The three kinds of sori are of the same form, and arise in the same manner, being restricted in size by the stomata. The aeciospores differ from the urediniospores by being smaller, more delicate and less angular. The teliospores germinate through the apex immediately upon maturity. The walls being very thin, collapse readily, and give an angular appearance to the spores. It was this peculiarity on which Raciborski founded the genus *Hemileiopsis*. The irregular, angular appearance of the partly collapsed teliospores is more or less evident in all species of the genus *Hemileia*.

THE NUTRITIVE VALUE OF PHILIPPINE CEREALS: II. GARIÑGAN TAPUCOY[1]

F. O. SANTOS AND ESTEBAN G. COLLADO
Of the Department of Agricultural Chemistry

WITH ONE CHART

Tapucoy is a variety of rice; Gariñgan Tapucoy is Tapucoy which is stored right after harvesting without being properly dried. Any rice is made into *gariñgan* either because it is harvested during the rainy season when there are no facilities for drying it or it is prepared intentionally by storing it undried. This is done because of the belief of some people that *gariñgan* rice stays longer in the stomach and thus delays the coming of the feeling of hunger.

In Mindoro the use of Gariñgan Tapucoy was common among the less prosperous farmers, who ate it unpolished. In 1923 a strange disease called *lapnus* was reported prevalent in that province (Lopez-Rizal et al, 1928). It appeared in epidemic form and caused high mortality. The disease was diagnosed by some physicians as pellagra; by others as malaria, yaws, syphilis, etc. The true cause of this malady is not known. Lopez-Rizal, Ylagan and Firme described the disease as follows:—

> It begins with anorexia and abdominal pain accompanied with vomiting and nausea. In some cases it begins like the morning sickness of pregnancy. These symptoms may last a week and when the attack is very mild no other symptoms develop and the patient gets well. Otherwise, there is felt a burning sensation in the hands and feet, followed within a month with red blackish spots or patches on the borders of the feet and dorsum of the toes and of the fingers. Sometimes these spots are either confluent or discrete varying in size from small dots to larger ones of about one centimeter in diameter. In all cases it looks as if they were blisters of a burn, but these, tho slightly elevated on account of the thickening of the skin accompanying it, do not contain any serum as in burn. One month later, if the patient gets well, the thickened skin begins to fall off gradually, leaving both hands, and especially the feet covered with a very thin and tender skin. There is usually no fever accompanying the disease. In severe cases, there is also fissuring of the lips and nose, lachrymation and flushing of the nose, the eyes and face. In still more severe cases, there is also frequent bowel movements, simulating dysentery, but in more severe "lapnus", the stool, if not pure blood, it is bloody and black in color. The patient in severe cases is compelled to lie in bed, while in mild cases, he is able to be about with no other hindrance but the pain due to the tender skin of the feet. At the time or during the subsidence of the skin and gastro-intestinal manifestations, patients became slightly or completely deaf, and the vision diminishes up to almost total blindness, sometimes only opacity of the cornea is noticeable. Falling of the hair occurs, and there are instances in which complete alopecia

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[1] Experiment Station contribution No. 790. Received for publication October 2, 1931. Paper I was published (1926) in THE PHILIPPINE AGRICULTURIST, **14**: 473–478.

> is observed. The disease terminates either in recovery or in death. When death occurs it is usually preceded by acute abdominal pains. A pregnant woman affected with lapnus delivers normally but later the baby usually develops keratitis on both eyes leading to total blindness. . . .
>
> The disease appears during the dry season. It affects people as early as February of every year but the majority of cases usually occurs during March and April, and subsides by August and September. Very rare cases occur after this time. The seasonal prevalence of the disease shows chronological relation with the time the rice, called "Gariñgan Tapucoy" is generally consumed by the people. This rice is harvested during September and October, stored without being properly dried, and is consumed by January of next year.

Because of the coincidence of the seasonal prevalence of the disease *lapnus* with the consumption of Gariñgan Tapucoy, the study of the nutritive value of this cereal seemed to be of interest and possible value.

The experiments here reported were performed in the Biochemical Laboratory of the College of Agriculture from September 28, 1928 to October 18, 1929.

MATERIALS AND METHODS

The materials used were:—Gariñgan Tapucoy, vegetable and butter fats, salt mixture, casein, filter paper and sweet potato leaves and shoots.

The Gariñgan Tapucoy rice was furnished by Dr. L. Lopez-Rizal of the Philippine Health Service. The age of the rice was not known. Germination test gave negative results. The rice was milled in one of the rice hullers in the barrio of San Antonio, Los Baños. In the sample used, the grains did not have the appearance of the common unpolished rice. They were either partly brownish in color dotted with white spots or whitish dotted with brown spots. The grains were unlike either the polished dead rice or the magalo rice and was very unappetizing in appearance. The sample had the following chemical composition, compared with that of unpolished ordinary rice:

	GARIÑGAN TAPUCOY	UNPOLISHED RICE
Moisture	11.93	11.43
Fats	1.60	1.44
Ash	0.98	1.19
Proteins	5.53	6.78
Crude fibers	0.45	0.63
N. F. E.	79.51	78.53

The vegetable fat used was the Purico brand, commonly found in the local market.

The salt mixture had the following composition (McCollum and Davis, 1915):

Sodium chloride	5	grams
Potassium biphosphate	12.1	"
Primary calcium phosphate (monohydrate)	2.56	"
Calcium lactate	29.44	"
Iron citrate	1.00	"

The casein, imported from Baker and Company, was ground into powder and washed five times with water. Butterfat was obtained from Golden State butter.

The filter paper was soaked in water, macerated, ground in a meat grinder and then dried in the sun.

The sweet potato leaves and shoots were obtained from the garden kept by the department.

Albino rats bred in our laboratory were used as experimental animals. At the beginning of the experiments all of the animals were apparently healthy. They were kept in individual cages.

Experience in our laboratory has shown that albino rats grow well on a diet of the following composition:

Unpolished rice	85	grams
Vegetable fat (Purico)	2.5	"
Butterfat	9.0	"
Salt mixture	3.1	"
Casein	13.0	"
Filter paper	1.4	"

When unpolished rice is replaced by polished rice the animals suffer from lack of vitamin B. The mixture given above forms one of our propagation diets.

We have also found that sweet potato leaves and shoots make a good supplement to an otherwise adequate diet but deficient in vitamin B (Santos and Collado, 1928).

Hence, the nutritive value of Gariñgan Tapucoy may be studied by using it instead of unpolished rice in an otherwise adequate diet, and sweet potato leaves and shoots as control source of vitamin B.

In the present experiments the animals were given Gariñgan Tapucoy instead of the ordinary unpolished rice. All the other ingredients of the food were the same as in the mixture described above. The amounts of nutrient in each diet are compared in the following table:

	UNPOLISHED RICE DIET	GARIÑGAN RICE DIET
	per cent	*per cent*
Moisture	8.52	8.89
Fat	11.15	11.28
Ash	3.60	3.45
Protein	16.45	15.53
Crude fiber	1.70	1.56
N. F. E.	58.58	59.29
Total	100.00	100.00

The diet and also water were given *ad libitum.*

RESULTS

Records of the body weights and food intake were taken weekly. The body weights are presented graphically in chart 1.

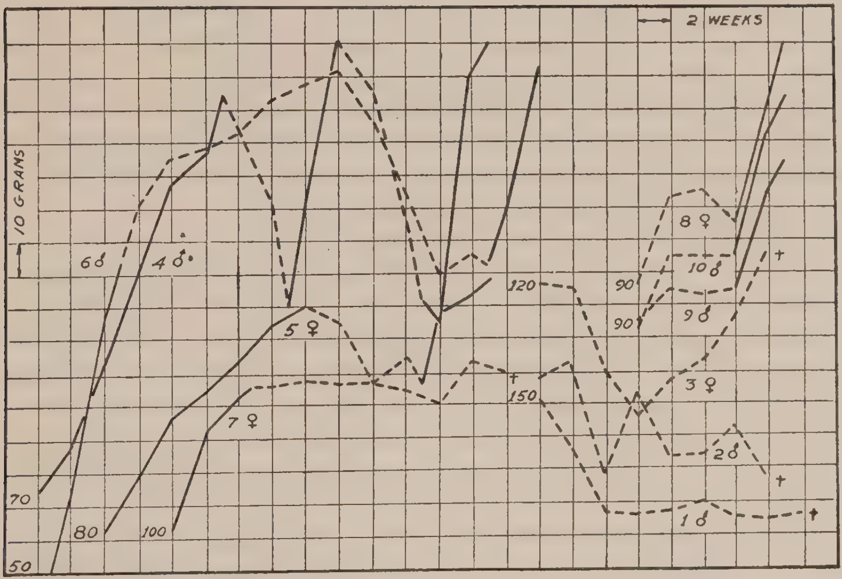

Chart 1.—Showing body weights of the rats.

Legend:

- - - - - - On Gariñgan Tapucoy diet

——— On Gariñgan Tapucoy diet plus sweet potato leaves and shoots.

On the Gariñgan Tapucoy diet alone, rats No. 2 ♂ and 3 ♀ died after 14 weeks and rat No. 1 ♂ after 16 weeks. Rat No. 7♀ on the same diet plus two grams of fresh sweet potato leaves and shoots grew well, but died 15 weeks after the supplement was removed.

Rats 8♀, 9 ♂ and 10 ♂ scarcely increased in weight on Gariñgan Tapucoy diet alone. But when this diet was supplemented with sweet potato leaves and shoots, the three animals exhibited steep growth curves.

Rat No. 5♀ grew on the diet supplemented with sweet potato leaves and shoots, but when the supplement was removed, the weight decreased. Then when the supplement was restored, the growth curve rose abruptly.

Rat No. 4 ♂ also gained weight on the diet plus the supplement but lost in weight every time the supplement was removed. Rat No. 6 ♂ on the diet supplemented with sweet potato leaves and shoots grew well and the increase in weight continued for some time after the supplement was removed. Finally, however, the animal lost weight. Recovery was obtained when the sweet potato leaves and shoots supplement was again given.

CONCLUSION

From the above results the following conclusions may be made:

1. Gariñgan Tapucoy when used instead of unpolished rice in an otherwise complete food mixture did not promote the growth of albino rats.
2. The improvement in the nutrition of the rats when sweet potato leaves and shoots were added to the diet seemed to indicate that Gariñgan Tapucoy is deficient in some accessory factor or factors.
3. Whether *lapnus* is associated with the eating of Gariñgan Tapucoy remains to be investigated. For this purpose it will be necessary to study the food habits of the people in the locality affected and to determine whether the same disease may be produced experimentally.

In May 12-14, 1930, the senior author visited Calapan, Mindoro a town where *lapnus* was reported to be prevalent. Only one person (an old man) was found afflicted with the disease. This man was fond of eating Gariñgan Tapucoy. The case was very advanced. Several cured persons were interviewed. These persons were inclined to believe that the disease was caused by eating Gariñgan Tapucoy. At the time of the visit no Gariñgan Tapucoy was found in the place. Dr. Mariano Ylagan, Health Officer for Calapan, has issued an order that the people shall not eat Gariñgan Tapucoy.

According to Doctor Ylagan several persons afflicted with the disease when taken to Manila and given a change in food improved, without being subjected to medical treatment.

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Santos, F. O., and E. G. Collado. 1928. The anti-beriberi vitamin content of sweet potato leaves and shoots. The Philippine Agriculturist **16:** 513–520. *Fig. 4.*

NATIVE METHODS OF PREPARING NAMÍ (DIOSCOREA HISPIDA DENNST.) TUBER FOR FOOD[1]

MAMERTO D. SULIT
Of the Division of Forest Investigation,
Bureau of Forestry

WITH THREE TEXT FIGURES

Often we hear the phrase, "What is one man's food, is another man's poison". A very striking example of this is the *namí* tuber which the Mangyans of Mindoro and the Negritoes of Tayabas eat with immunity. The *namí*, as is well-known, is poisonous unless it is properly treated and well cooked. The Mangyans and the Negritoes, however, cook and eat it without any preliminary treatment. It is strange that these peoples should be immune from the fatal effects of untreated *namí*. Whether or not Nature has endowed them with anti-toxic organs, I cannot tell. Some say that these wild tribes use an antidote which they alone know and which they will not reveal to any one.

The Christian Filipinos have discovered that *namí* is a delicacy. But like many delicacies it requires a very careful preparation. If not carefully prepared by the proper methods and treatment *namí* is unsafe for human consumption. During shortage of food it is used as a substitute for rice. The object of this paper is to describe some Filipino methods of preparing *namí*.

BOTANICAL DESCRIPTION AND DISTRIBUTION

Dioscorea hispida Dennst. known as *namí* in Mindoro, Laguna and Rizal, *lamí* in Batangas, *kalut*, *kulot*, *korot* in Zambales, *korote* in Zamboanga, *kayos* in Tayabas, *korot* in Samar and Leyte and *namó* in Camarines is a twining woody vine from tuberous roots, attaining a length of several meters, depending upon the height and length of its supporter. The stem has sharp, short and ridged spines, sometimes many, sometimes few. "Leaves 3-folio-late, the leaflets 12 to 20 cm. long, acuminate somewhat pubescent, the lateral ones, oblong to oblong-ovate, terminal one equilateral, oblong to oblong-ovate. The flowers are small, pale yellow, and are borne on compound inflorescence which are usually large. The fruits are about 5 cm. long and divided into three thin lobes, which are more than twice as long as wide." In some parts of the Philippines, *namí* is occasionally cultivated for medicinal purposes. In central Luzon it flowers in June and July.

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[1] Miscellaneous contribution No. 6. This paper was read before the Los Baños Biolcgical Club, July 30, 1931. Received for publication September 9, 1931.

It is distributed throughout the Philippine Islands, especially in the central provinces of Luzon and in the northern part of Mindanao, in thickets and forests at low and medium altitudes.

MATURITY

The tuber at maturity, attains an enormous size; sometimes one tuber weighs 10-15 kilograms; a single plant may contain from 3-5 tubers, depending upon the locality where it grows. At the beginning of the dry season the stem of the *namí* dies, the tubers remain in the ground in the form of a mound similar to that of an ant hill. (See fig. 1).

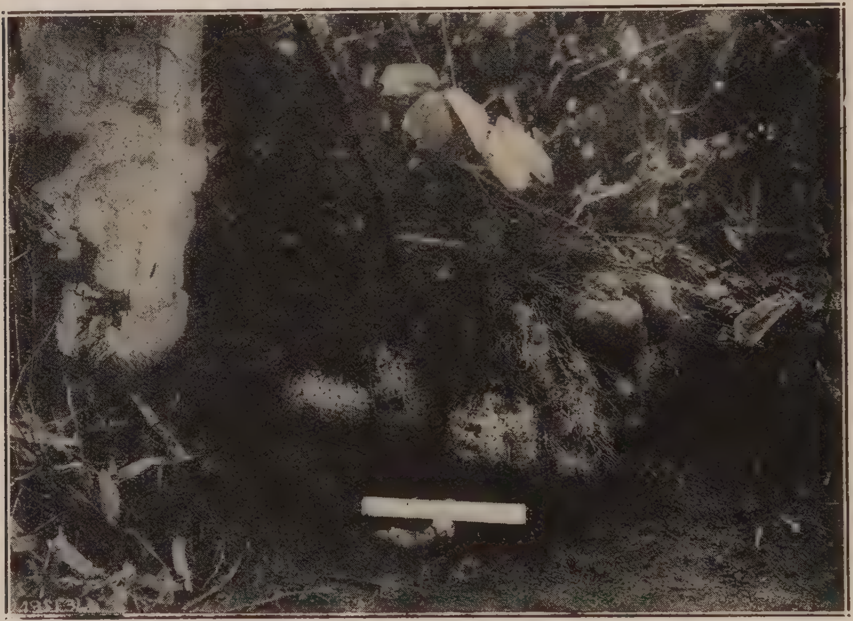

Fig. 1.—*Namí* (*Dioscorea hispida* Dennst.) in its natural habitat. This particular plant contains 16 tubers, weighing 51½ kilograms.

In the Maquiling National Botanic Garden and vicinity, the leaves of *namí* turn yellowish in color in November and December. This is the proper time to collect or harvest the tubers as they are then full size. In Lobo, Batangas, where *namí* is abundant, the tubers are harvested in January and February.

CHEMICAL CONTENTS

The tubers of *namí* when eaten without treatment are very poisonous. They cause dizziness and nausea, if not death. Dr. Leon Guerrero of the

Bureau of Science who is in charge of the investigation of medicinal and poisonous plants, reports that the tuber of *namí* contains two alkaloids; one which is fixed, *dioscorin*, is highly toxic, one centigram being sufficient to kill a horse; the other, is *dioscorein*, which is volatile and is less toxic. Dr. Miguel Manresa, formerly of the College of Veterinary Science and now of the College of Agriculture, reports that the tuber of *namí*, sliced and pounded fine in a mortar and mixed with lime, is an effective cure for *myiasis* in cattle.

METHODS OF PREPARATION FOR FOOD

There are several methods, depending upon the locality, of preparing *namí* tubers for human consumption. The Batangas and Los Baños methods will be described here as the writer is more familiar with them than with others. The rind which contains numerous rootlets is peeled off, then the tuber is sliced into very thin pieces. (See fig. 2). In Bolbok, Batangas, a device called *yadyaran* is used for slicing the *namí* tuber. It is something like the carpenter's plane, but instead of pushing the plane, the tuber is pushed over its knife. The sliced material is placed in a basket, which is then placed in sea water for two or three hours, depending upon the thickness of the slices. The contents of the basket are stirred once in a while. When the sliced *namí* is soft and pliable, the basket is taken from the water and a weight placed on top of the slices to press out the water. After two or three hours the basket is placed half-submerged in fresh running water, usually in a creek, to wash out the salt and other undesirable materials clinging to the slices. It is left in the creek, stirring the slices once in a while, for thirty-six to forty-eight hours.

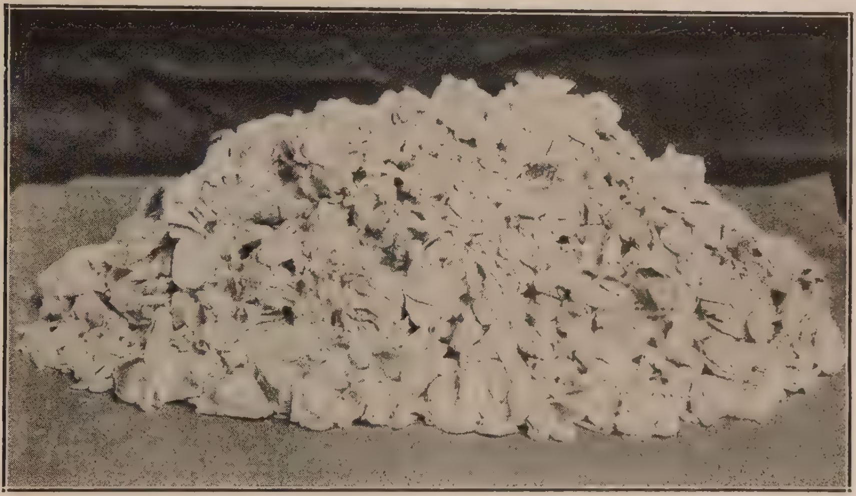

Fig. 2.—Sliced *namí* which has been treated and is ready for cooking.

The *namí* is supposed at the end of this treatment to have lost all its poisonous chemical content. As evidence of this state, crustaceans and small fishes in the creek gather around the basket and start to eat the slices. Another method of testing it, is to squeeze one or two pieces between the fingers and then allow one or two drops of the juice to drop on the eyes. If there is no irritating effect, the treated material is ready to be cooked. If there is an irritating effect on the eye, the material should be left longer in the water.

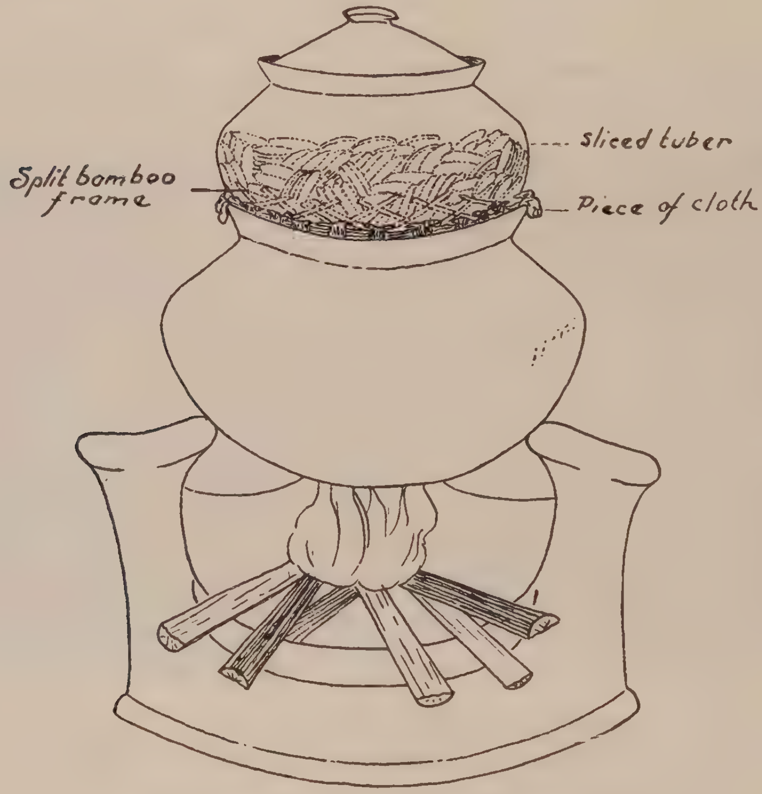

Fig. 3.—*Kalangkang* method of cooking treated *namí*.

Another method which is practiced in Los Baños and in nearby towns is to add salt to the sliced *namí*. The proportion is one liter of salt to a petroleum can full of slices. For salting, the sliced *namí* is put in a wash tub or any convenient container. It is left in the salt for not less than twelve hours and is then put in a basket and placed in fresh running water as in the first method described.

Another method of testing the sliced material as to whether or not it is fit for human consumption is to cook a small quantity, mix it with sugar, and give it to a dog or cat. The animal is closely observed for about an hour. When there is no effect detected on the animal, the material is considered safe. This method of testing is practised in northern provinces of Luzon, Cagayan, Pangasinan, etc., and also in the Bicol region.

METHODS OF COOKING

There are several ways of cooking *namí*. It can be cooked just after taking the basket from the water. In Lobo, Batangas and in the barrio, San Antonio, Los Baños, the process of cooking called *kalangkang* is by steaming. Enough of the treated *namí* for a meal for a family, is placed in an earthern pot supported with split bamboo frame, but broken at the bottom to allow the steam to pass through. (See fig. 3). This pot is placed on top of another pot containing boiling water. The *namí* is cooked by the steam from the lower pot. When the color changes from whitish to yellowish, which will be in from ten to fifteen minutes, the *namí* is ready to be served. To make it more palatable, sugar and shredded coconut meat are added. The *namí* is also cooked by frying it in lard or coconut oil.

Sometimes, when a large quantity is prepared the sliced *namí* is dried in the sun. Pounding this dried *namí* in a mortar makes it whitish and powdery like flour. This flour can be cooked in a good many ways, as in *bibingka*, *suman*, *maruya*, hot cake and other kinds of sweets.

HOUSEHOLD REMEDY

Another family use of the *namí* tuber is as a remedy because of its antiphlogistic property. Inflammation and pain caused by the sting of poisonous fishes, such as the *lupo* (*Scorpaenidae*), sumbilang (*Plotosus anguilaris* (Bloch), sting-rays, etc., are reduced and eased by an application of a *namí* paste. The tuber is scraped very fine, heated and then applied to the stung part.

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DENDROBIUM PROFUSUM SCHLECHTER[1]

N. B. MENDIOLA
Of the Department of Agronomy

WITH TWO TEXT FIGURES

It should be of interest to collectors of Philippine orchids as well as to tropical botanists to learn of the discovery of a rare *Dendrobium* in the Philippines. Herbarium specimens of this *Dendrobium* were sent by the writer to Doctor Oakes Ames of Harvard University on February 3, 1931

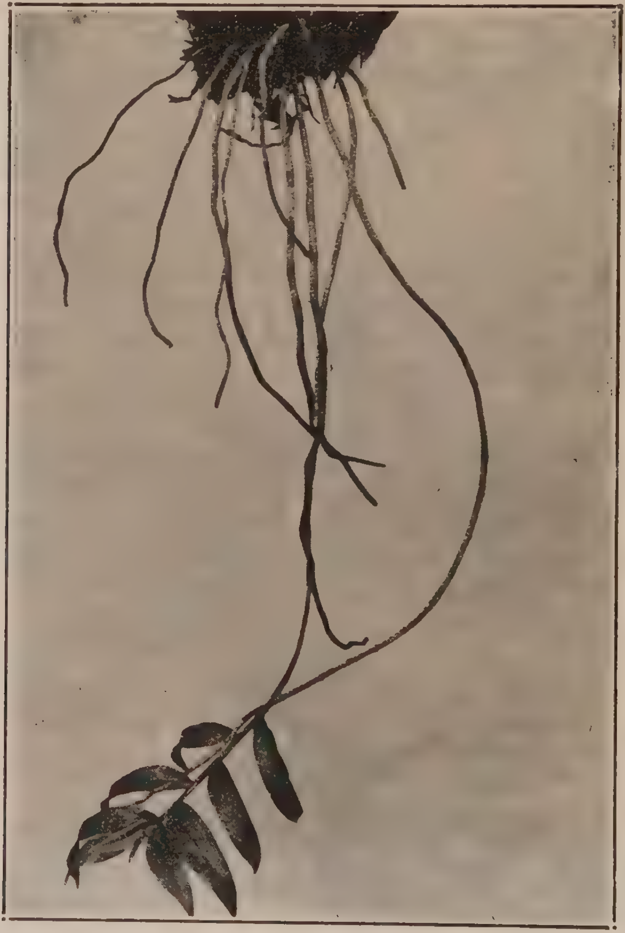

Fig. 1.—*Dendrobium profusum* Schlechter.

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[1] Experiment Station contribution No. 796. Received for publication January 12, 1932.

for identification and the following answer was received from him: "The orchid sent to me for determination, proves to be the rare *Dendrobium profusum* Schlechter. This species has been understood only through the type material so that your discovery of it is something to be thankful for." The specimen sent to Doctor Ames came from a place in Pakil, near the boundary of Laguna and Tayabas provinces. According to Mr. Moises S. Villaluz, an orchid grower whose post office address is Agricultural College, Laguna, and who has been growing this *Dendrobium* under culture, it has flowered twice a year. The stems of *D. profusum* are about one meter long, pendent, but curving at the end. They have a wrinkled surface, are smaller and more slender than stems of *D. anosmum* Lindley. The leaves are narrower than *D. anosmum*, and are about 14 centimeters long, and 2.5 to

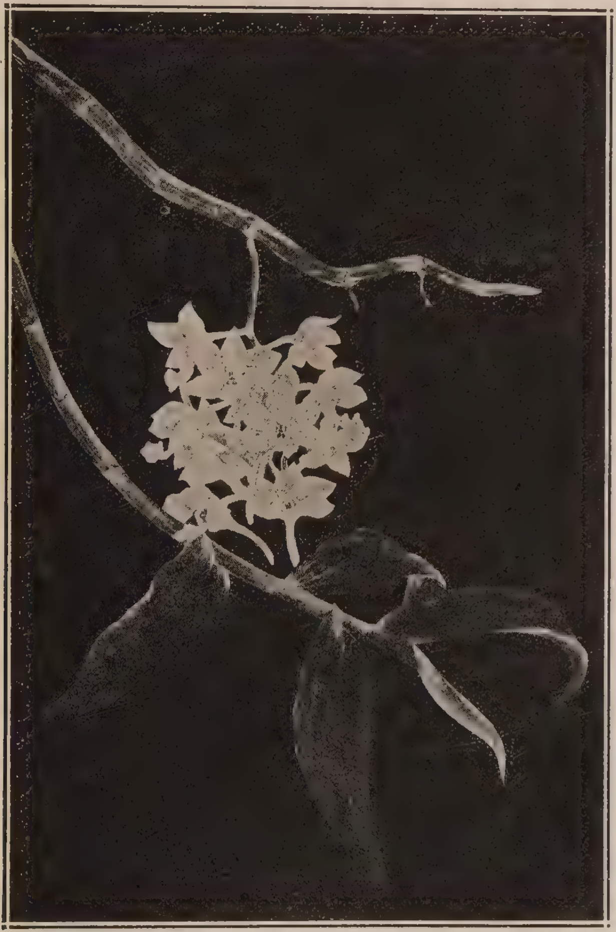

Fig. 2.—*Dendrobium profusum* Schlechter in flower.

3.3 centimeters broad. The veins are not as prominent as those of *D. anosmum*,. The flowers are borne in clusters. Each stem bears one to three clusters and each cluster contains about fourteen individual flowers. Each flower measures about 3.5 centimeters from the tip of one sepal to that of another and about 4.3 centimeters from the tip of the middle sepal to that of the tube. The sepals are light green in color at the back while in front they are light cream. The petals are also light cream in color. Both the sepals and petals are covered with purple dots on the ventral and dorsal sides. The flowers bear no scent. *Dendrobium profusum* may be considered as an ornamental orchid and deserves a place in an orchid collection.

NOTES ON THE CRUSTACEAN AND MOLLUSCAN FISHERIES OF LAKE TAAL AND THE PANSIPIT RIVER[1]

DEOGRACIAS V. VILLADOLID
Of the Department of Entomology

CRUSTACEAN FISHERIES

The katang fishery

One important fishery in Lake Taal, although not belonging to the ichthyological group is the katang fishery. The katang is a small crab probably belonging to the genus *Potamon* or *Parathelpusa,* family Potamonidae or its near relative. These crabs, like the transient species of fish of Lake Taal, have the habit of migrating between the lake and the open sea by way of the Pansipit River. It has been observed that beginning in December and extending to the early part of April of each year, the migrations of this crab take place. Large runs of adult crabs in their seaward migration for purposes of breeding in the salt water have been regularly observed during December and January, while the lakeward ascent of young crabs takes place during the rainy season, from August to October. One curious phenomenon in this connection is the extraordinary large runs of young crabs during the period of a new moon.

The katang are caught for food; some of them are prepared by boiling; a great many are pickled in salt as *buro;* and a considerable percentage of the catch is made into a salty sauce known as *patis.*[2]

Apta, or yapyap, fishery

Another crustacean fishery product that is worth mentioning is the apta, or yapyap. This is a species of minute prawn belonging to the family Atyidae. These crustaceans are taken in large quantities in Lake Taal, especially from the eelgrass regions along the shores of the volcano islands. The most common device used for catching this prawn is the *sima* or *salap* (scissors nets made of *sinamay* cloth).

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[1] Report No. 3, on an investigation trip in April, 1931, for the purpose of studying the fisheries of Lake Taal and the Pansipit River, Batangas Province.

Experiment Station contribution No. 791. Received for publication August 28, 1931.

[2] *Patis* is prepared as follows: The crabs are crushed and ground fine in a wooden or stone mortar. Then they are boiled in water with plenty of salt so as to produce a salty sauce. This sauce, or liquid is separated as the *patis,* while the sediment is used as *heko.*

The apta are sold fresh for the table; dried for chicken feed; or heavily salted for making *alamang.*[3]

MOLLUSCAN FISHERIES

Paros fishery

The people of Taal and Lemery find in the mouth of the Pansipit River an important source of molluscan food. It is a species of fresh-water mussel locally known as paros.[4] This mussel is present in large numbers along the sandy bottoms of the Pansipit River and is collected by means of dredging sieves made from bamboo splits. These sieves are known as *bithay.*

Suso fishery

The inhabitants of the islands in Lake Taal take advantage of the presence of large quantities of suso, *Melania blatta* Lea, at times when their fishing gear fail to yield the usual catch of fish for home consumption.

It may be of interest to note that the species of mollusks which serve as the usual feed for domesticated ducks (itek, *Anas boschas* Linn.) in Laguna de Bay regions are also present in Pansipit River and in Lake Taal, especially along the shores of the isolated islands in the lake. In the order of their abundance, they are: *Melania lateritia* Lea, *M. pantherina* von dem Busch, *M. scabra* Müller, *M. blatta* Lea, *Vivipara angularis* Müller, and *Corbicula manillensis* Philippi. The abundance of these mollusks indicates that the duck-farming industry would find a supply of food around Taal Lake and along the Pansipit River. This industry would find also ideal sites on the islands in the lake.

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[3] *Alamang* is salted yapyap or apta or other minute crustaceans which are ripened in suitable containers such as tin cans or earthen jars where the preparation is not accessible to flies and dirt.

[4] Specimens of this mussel have been sent to Mr. Howard Hill, conchologist of the Los Angeles Museum, Exposition Park, Los Angeles, California, U.S.A., for identification.

A HANDY DUSTER FOR THE SMALL GARDEN[1]

LEOPOLDO B. UICHANCO
Of the Department of Entomology

WITH ONE TEXT FIGURE

Quite frequently, in a flower or vegetable garden around the home, insect depredation could be prevented, or at least minimized, if proper measures were taken in time. Commonly, a great handicap of the home gardener is the lack of adequate facilities, which should be available on short order, for controlling insect pests. A supply of ingredients that are ordinarily used for the preparation of insecticides is convenient to have in stock for use in cases that call for insecticides. These ingredients are not expensive and are ordinarily on sale by certain firms in Manila. Such substances as the standard arsenicals, when purchased as dry powder, do not deteriorate in storage, provided they are kept in a dry place. Bucket pumps equipped with good disc nozzles and small mechanical dusters that may be strapped on the shoulders and operated by means of a hand crank may be purchased for about fifteen pesos each. Except for the leather washers and rubber hose of the pump, which have to be changed at very infrequent intervals, when worn out, these equipments, if given reasonable care, will give many years of service. For limited spraying with such liquid insecticides as soap solution or tobacco decoction, an ordinary hand atomizer, like the ones sold in stores for use in connection with "Flit" and similar fluids, is quite satisfactory. It must be rinsed out with clean water and dried thoroughly after using. It should not be employed in the application of arsenicals or other metal-corroding compounds.

For ordinary purposes in the control of leaf- or flower-eating insects, like lady beetles on tomato and eggplant, chrysomelid beetles on patola, upo, squash, watermelon and cucumber, grasshoppers on rose petals, scarabaeid beetles on rose leaves, and caterpillars on cabbage, pechay and other vegetables, we found a very simple home-made dusting apparatus to work satisfactorily. It consists of a fair-sized, wide-mouth bottle, like an ordinary pickle bottle, cork to fit, a piece about 15 centimeters square, of fine-meshed cloth, like voile, and about one-half meter of No. 20 galvanized wire. The clean, dry bottle is filled one-half to three-quarters full of the dusting mixture and the piece of cloth pressed snugly into the mouth by

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[1] Experiment Station contribution No. 792. Received for publication September 3, 1931.

inserting the cork. Then the protruding edges of the cloth are stretched downward against the lip of the bottle, tied around firmly beneath the lid with two turns of the wire, and trimmed. (See fig. 1a.) The bottle should be labelled in order to identify its contents. After removing the cork, the apparatus is used like a pepper shaker. (See fig. 1b.) One advantage of this device over the old cloth-bag method is that the dusting mixture may be kept in storage in the same bottle that serves as duster, by merely shaking the dust off the cloth and lid of bottle and replacing the cork stopper after each operation. This method avoids waste of material. Another distinct advantage is that the duster is always ready for immediate use, thus obviating irksome delay in preparing equipments, which frequently leads to procrastination. The writer has found this device a great convenience in his garden; and it is described here in the hope that others may find it equally useful. In the control of pests of field crops, like the destructive tobacco bud worm, *Heliothis armigera* Hübner, which is difficult to reach with a machine duster, a simple equipment such as the one here described may also prove a welcome supplement.

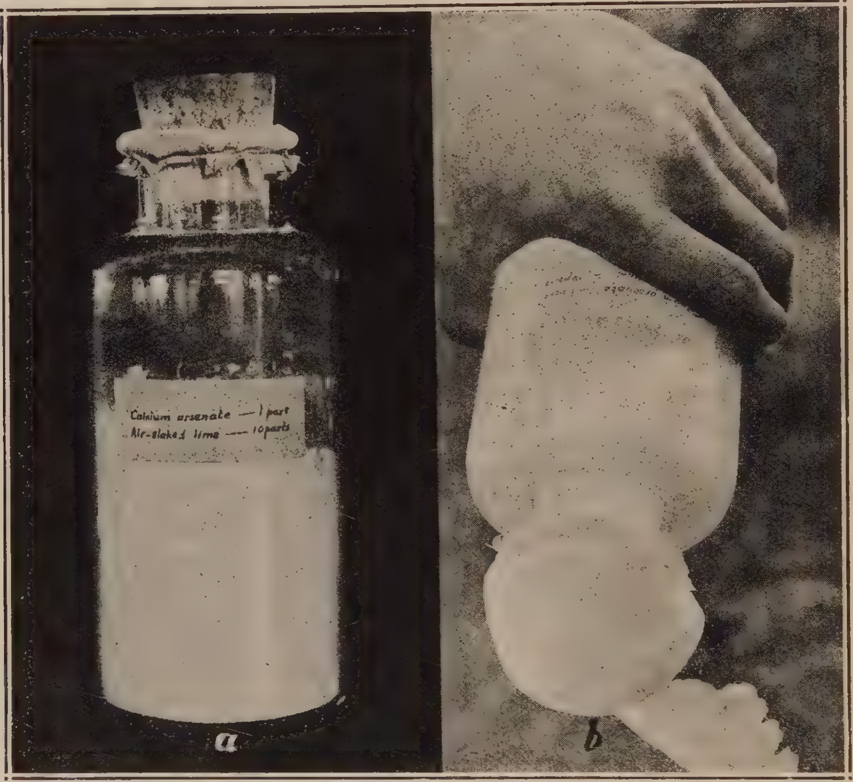

Fig. 1.—Views of the duster. *a*, closed; *b*, in use.

In general, in dealing with leaf-eating insect pests that may be controlled with arsenical insecticides, we found the following dusting mixture effective, and at the same time harmless to most foliage, under Philippine conditions:

Calcium arsenate, powder	1 part by weight
Air-slaked lime	10 parts by weight

Sift the ingredients separately through a piece of fine-meshed cloth and weigh the required amounts. Mix and sift two or three times in order to effect a uniform combination. A large quantity may be prepared at a time; the mixture keeps almost indefinitely.

The best time for dusting is early in the morning, when the leaves are still moist with dew and there is almost no breeze.

EFFECTS OF THE RATE OF SEEDING UPON THE YIELD OF UPLAND RICE[1]

ALEJANDRO B. CATAMBAY[2] AND SANTIAGO R. CAPCO
Of the Department of Agricultural Engineering

WITH TWO GRAPHS AND ONE TEXT FIGURE

In the growing of upland rice, the seed is one of the factors affecting the cost of production. It was the aim of this study to obtain experimental data regarding correct rate of seeding.

OBJECTS AND PLACE OF PRESENT WORK

The definite objects of the present work were: (*a*) to determine the relation of the rate of seeding upon the production of upland rice; and (*b*) to determine the rate that will give maximum production.

The work covered the period from April, 1930 to November, 1930. It was conducted in the Farm Management Unit, division XXV of the College Experiment Station. The drill was calibrated in the laboratory of the Farm Management Division, Agronomy Department.

MACHINERY AND RICE

Tractor. The tractor used was a standard Fordson Tractor, Model 1929 (fig. 1). It develops approximately 10-horse power at the draw bar and 20 at the belt. The tractor is of wheel type with cleats on the two rear wheels. These cleats are provided to secure traction in pulling.

Oliver 2-24″ disc plow. This plow is a two-disc tractor-drawn gang plow. Each disc blade has a diameter of 24 inches, or 60.96 centimeters. It is mounted on three wheels, the land wheel, front furrow wheel, and the rear furrow wheel. There are two levers the purpose of which is to regulate the depth of plowing and the levelling of the plow bottoms. The plow is provided with a power lift for raising it when turning and when it is being moved from one place to another. The power lift is operated from the tractor driver's seat by a trip rope.

La Crosse 32-16″ disc harrow. This implement is a double disc harrow. The 32 discs have a diameter of 16 inches, or 40.64 centimeters. It is composed of two sections with a cut 8 feet, or 2.43 meters wide. The harrow is provided with single lever to change the angle of the sections to suit the working conditions. Its shipping weight is approximately 1136 pounds, or 516.360 kilograms.

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[1] Portions of the material in this paper were included by the junior author in his thesis presented for graduation, 1931, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 408; Experiment Station contribution No. 793. Received for publication July 9, 1931.

[2] Mr. Catambay was transferred from Department of Agronomy to the Department of Agricultural Engineering on April 1, 1931.

Grain drill. The La Crosse grain drill plants 18 rows with a distance of 7 inches, or 17.8 centimeters between the rows. The drill is divided into halves and each half can be operated independently of the other. This division is necessary to complete the planting of the field.

The seed box is of plain type provided with a cover which opens and shuts with a spring and with a double truss to prevent sagging. There are two grain gauges, one on each half, which regulates the rate of seeding. The drill has 18 adjustable external fluted feeds. The seed falls into the steel ribbon tubes, which end behind the single disc furrow openers. Behind the disc furrow openers are small boots within the furrow cut to insure the depositing of the seeds at the bottom of the furrow. A short chain dragged behind the furrow opener covers the seeds. The drill is also equipped with power lifts, one on each half which are operated from the tractor driver's seat by a trip rope. These power lifts are necessary in raising the furrow openers when the drill is moved from place to place.

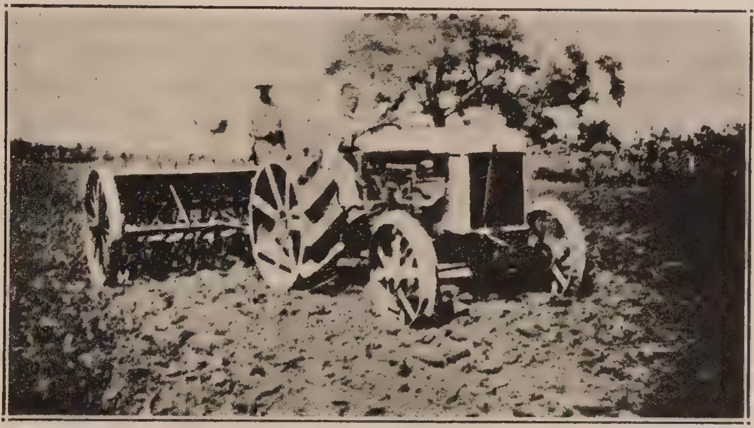


Fig. 1.—"La Crosse" grain drill in operation pulled by a 10-20 h. p. Fordson Tractor (front view.)

Eureka weeder and mulcher. This implement is animal-drawn; it has 32 spring teeth and a cut 12 feet, or 3.65 meters wide. It is provided with two wheels and a seat for the driver. This implement serves either as a weeder or as a cultivator.

Planet Jr. cultivator. This implement is animal-drawn; it has seven teeth. It has means by which the number of teeth may be reduced and the width of cut varied to suit working conditions.

The variety of upland rice used was the Inintiw, a very common variety planted by farmers of Los Baños, Laguna.

PREPARATION OF THE FIELD

The field, just after the harvest of the dry season corn crop, was plowed lengthwise. In plowing, a tractor-drawn Oliver 2-24″ disc plow, and a standard Fordson tractor were used with a man as operator. This first plowing turned under weeds and trash and exposed the root stock of the previous crop. The first plowing was followed by the first harrowing with the tractor-drawn La Crosse disc harrow. No more work was done on the field until the first crop of weeds had attained a height of from about 5 to 10 centimeters. Then the second plowing was done. This plowing was cross-wise to further loosen the soil and destroy practically all the weeds. Harrowing followed. It was necessary to harrow the field for the third time before seeding to destroy the weeds that had germinated and to make the surface level. This harrowing also thoroughly pulverized the soil, thus giving a perfect rice seed bed.

METHOD OF TESTING

Laboratory calibration of the grain drill

Determination of the amount of seed falling at different gauges. The La Crosse grain drill was mounted on wooden supports which allowed the wheels to turn freely. The seed box was filled with Inintiw palay seed. The process of calibration was to open the throat of the external fluted feed, then revolve the wheels ten times and collect the seed in paper bags. The seed falling at each test was weighed. Tests were made for seven different widths of opening. One centimeter was the minimum throat opening and 3.8 centimeters was the maximum. The results are shown in table 1. With 3.20 meters as the width of the drill, the ten revolutions of the wheels, the circumference of which is 3.51 meters, will cover approximately 112.32 square meters of ground.

Field test

Seeding was done in the middle of June. There were eight rates of seeding used with the following throat openings: for 30-kgm. rate of seeding per hectare the opening was 0.699 cm.; for 40-kgm. rate, 0.932 cm.; for 50-kgm. rate, 1.165 cm.; for 60 kgm. rate, 1.398 cm.; for 70-kgm. rate, 1.631 cm.; for 80-kgm. rate, 1.864 cm.; for 90-kgm. rate, 2.097 cm.; and for 100-kgm. rate, 2.330 cm. These different throat openings which gave desired rate of seeding per hectare were obtained from the result of the drill calibration, which is shown in graph 1. The straight line in this graph was maintained, showing that the drill was in perfect working condition.

For every rate of seeding there were 22 lots, so that in all there were 176 lots. Each lot had an area of 64 square meters.

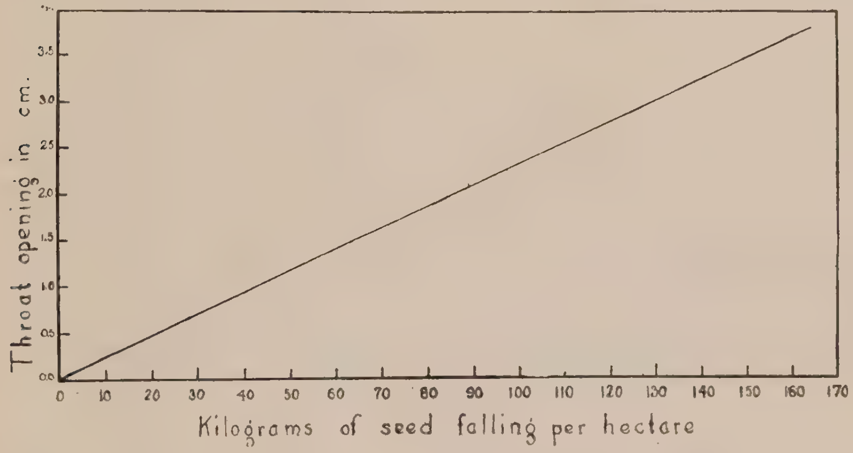
WEEDING

Weeding was done when the rice plants were about 15 to 20 centimeters high. The weeder and mulcher pulled by a bullock was passed across the field to remove the newly germinated vines. When the rice plants reached a height of about 30 cm., weeding was done with hand trowels and sickles.

Animal-drawn Planet Jr. cultivator was used for cultivation. The teeth were made to pass between the rows, thus loosening the soil and cultivating the rice plants. This operation also destroyed the weeds left after the hand weeding.

HARVESTING

The palay was harvested on October 30, 1930. The harvest from each lot was separated and separately threshed by treading. The palay was dried on a concrete floor. When thoroughly dry and cleaned the final weights were taken separately for each lot.



Graph 1.—Showing throat opening at different rates of seeding.

EXPERIMENTS AND RESULTS

The results of this investigation are compiled in tables 1 to 3. Table 1 shows the result of the laboratory calibration of the La Crosse grain drill. The average amount of seed falling at different gauges in ten revolutions were: for 1.0 cm. opening the fall was 0.324 kgm., or 28.846 kgm. per hectare; for 1.5 cm., 0.745 kgm., or 66.327 kgm. per hectare; for 2.0 cm., 1.085 kgm., or 96.598 kgm. per hectare; for 2.5 cm., 1.480 kgm., or 131.764 kgm. per hectare; for 3.0 cm., 1.714 kgm., or 142.597 kgm. per hectare; for 3.5 cm., 1.832 kgm., or 153.103 kgm. per hectare; and for 3.8 cm., 2.010 kgm., or 178.950 kgm. per hectare.

Table 2 shows the actual throat opening of drill with corresponding amount of seed planted on the 64 sq. m. lots. The approximate amounts of seed drilled to the 64 sq. m. lots were: for 30-kgm. rate of seeding per hectare, 0.192 kgm.; for 40-kgm. rate, 0.256 kgm.; for 50-kgm. rate, 0.320 kgm.; for 60-kgm. rate, 0.384 kgm.; for 70-kgm. rate, 0.448 kgm.; for 80-kgm. rate, 0.512 kgm.; for 90-kgm. rate, 0.576 kgm.; and for 100-kgm. rate, 0.640 kgm.

Table 3 shows the frequency distribution of 22 hectare plots and the variation in kilograms in the production per hectare at different rates of seeding. The production per hectare of lots with 30-kgm. rate of seeding was 592.682 ± 8.924 kgm.; 40-kgm. rate, 884.00 ± 6.707 kgm.; 50-kgm. rate, 1,038.227 ± 8.003 kgm.; 60-kgm. rate, 1,079.591 ± 9.497 kgm.; 70-kgm. rate, 1,336.045 ± 10.697 kgm; 80-kgm. rate, 1,241.864 ± 12.078 kgm.; 90-kgm. rate, 1,155.258 ± 8.258 kgm.; and 100-kgm. rate, 1,100.764 ± 8.355 kgm.

DISCUSSION OF RESULTS

Effects of the rate of seeding on the stand of seedlings

The 30-kgm. rate of seeding per hectare had a throat opening of 0.699 cm. which was too narrow for the seeds to pass freely. It caused some of the seed palay to be cracked or otherwise injured. Hence, reduced the percentage of germination and resulted in a poor stand of the seedlings. The 70-kgm. rate produced seedlings with regular stand and with enough space for proper development. This rate gave the highest yield. Above the 70-kgm. rate of seeding the leaves of the seedlings were yellowish in color showing that the rate was too heavy. The 100-kgm. rate of seeding produced so thick a stand of seedlings that the plants were stunted.

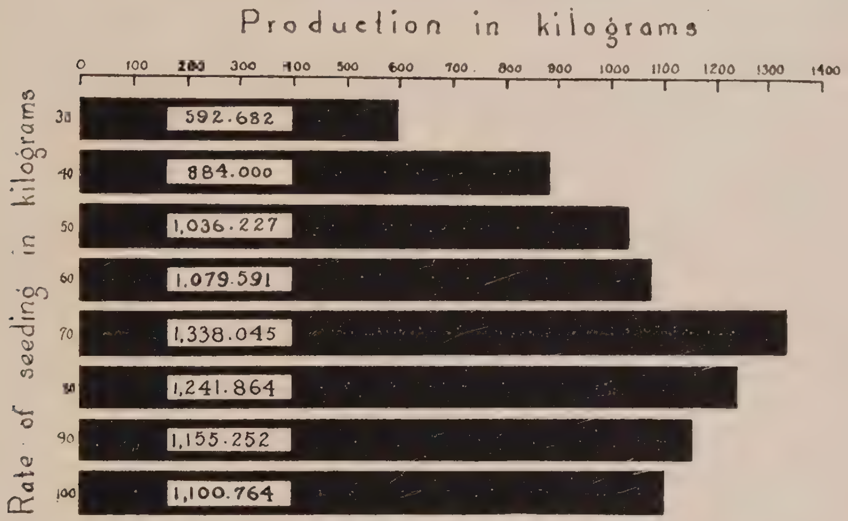
Effects of the rate of seeding on the growth of weeds

The weeds in upland rice are so abundant as to sometimes cause crop failure. A thick growth of weeds was observed in the lots with the 30-kgm. rate of seeding per hectare. The thin stand of seedlings provided more space for weed growth. Consequently, the cost of weeding in these ots was very high as compared with the lots of heavier rate of seeding. There were many weeds in the lots with 40-, 50- and 60-kgm. rate of seeding but not so many as in the lots with the 30-kgm. rate. There were comparatively few weeds in lots with 70-kgm. and 80-kgm. rates. In the lots with the 90-kgm. and 100-kgm. rates of seeding, the thick stand of the seedlings practically checked the growth of weeds, as there was not enough space for them to grow.

Effects of the rate of seeding on the yield

Table 3 shows the yield per hectare in all lots. The 30-kgm. rate of seeding gave the lowest yield per hectare because of the thick growth of weeds and very thin stand of seedlings. The 70-kgm. rate of seeding gave the heaviest yield as the plants were able to develop properly as there were few weeds. The rates above 70-kgm. rate gave higher yields than the rates below, because the lots having the higher rates were less infested by weeds and had a thicker stand of seedlings than the lots with the lower rates.

Graph 2 shows the mean production per hectare of the different rates of seeding. The 30-kgm. rate had a production represented by the shortest block while the 70-kgm. rate is represented by the longest. It may be observed that increasing the rate of seeding per hectare beyond 70 kgm. caused a gradual decrease in production. This result conclusively shows that the rate of seeding has some effect on the production of upland rice.



Graph 2.—Showing the production per hectare of the different rates of seeding.

SUMMARY OF CONCLUSIONS

1. The rate of seeding has some effect on the yield of upland rice.

2. At the 30-kgm. rate of seeding per hectare, the throat opening of the drill was so narrow that it caused some of the seed palay to be either crushed or cracked.

3. The 30-, 40-, 50-, and 60-kgm. rates produced a thin growth of seedlings leaving wide spaces for weeds to grow. These lots were heavily infested with weeds.

4. The 70- and 80-kgm. rates produced a good stand of seedlings and were less infested with weeds than the seedlings from first four rates of seeding.

5. The 90- and 100-kgm. rates of seeding per hectare produced a very thick growth of seedlings, but, although they were the least infested with weeds, the seedlings, because they were crowded, were later stunted and became yellowish in color.

6. The 30-kgm. rate gave the lowest yield per hectare (592.682 ± 8.924 kgm., or 13.470 cavans). The yield increased with the subsequent increase in the rate of seeding up to the 70-kgm. rate which produced the highest yield (1,336.045 ± 10.697 kgm., or 30.365 cavans). The corresponding yields were: 40-kgm. rate, 884.000 ± 6.707 kgm., or 20.091 cavans; 50-kgm. rate, 1,038.227 ± 8.003 kgm., or 23.596 cavans; and 60-kgm. rate, 1,079.591 ± 9.497 kgm., or 24.536 cavans.

7. The yield per hectare gradually decreased with further increase in the rate beyond 70-kgm. The corresponding yields were: 80-kgm. rate, 1,241.864 ± 12.072 kgm., or 28.224 cavans; 90-kgm. rate, 1,155.258 ± 8.258 kgm., or 26.256 cavans; and 100-kgm. rate, 1,100.764 ± 8.355 kgm., or 25.017 cavans.

8. The seeds planted by the drill were well covered, hence less exposed to birds than when broadcast.

TABLE 1

Laboratory calibration of La Crosse Drill[a]

THROAT OPENING / TEST NO.[b]	WEIGHT OF SEEDS FALLING AT DIFFERENT THROAT OPENINGS						
	1.0 cm.	1.5 cm.	2.0 cm.	2.5 cm.	3.0 cm.	3.5 cm.	3.8 cm.
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
1	0.297	0.677	1.047	1.460	1.750	1.850	2.050
2	0.323	0.785	1.088	1.470	1.740	1.850	2.050
3	0.331	0.747	1.090	1.480	1.710	1.860	2.020
4	0.328	0.755	1.094	1.490	1.660	1.830	2.000
5	0.343	0.762	1.105	1.500	1.710	1.770	1.980
Total.........	1.622	3.726	5.424	7.400	8.570	9.160	10.100
Average.......	0.324	0.745	1.085	1.480	1.714	1.832	2.010
Amount per hectare.......	28.846	66.327	96.598	131.764	142.597	153.103	178.950

[a] Width of drill, 3.2 meters; circumference of wheel, 3.51 meters.

[b] There were 10 revolutions of the wheel for every test.

TABLE 2

Actual throat opening of drill

GAUGE NO.	THROAT OPENING	ACTUAL WEIGHT OF SEEDS DRILLED ON 64 SQ. M.	WEIGHT OF SEEDS DRILLED PER HECTARE
	cm.	*kgm.*	*kgm.*
1	0.699	0.192	30
2	0.932	0.256	40
3	1.165	0.320	50
4	1.398	0.384	60
5	1.631	0.448	70
6	1.864	0.512	80
7	2.097	0.576	90
8	2.330	0.640	100

TABLE 3

Frequency distribution of 22 hectare plots showing variation in kilograms in the production per hectare at the different rates of seeding

CLASS RANGE	VALUE OF RANGE	RATE IN KILOGRAMS OF SEEDING PER HECTARE							
		30	40	50	60	70	80	90	100
kgm.	*kgm.*								
462— 487	474.50	1							
488— 513	500.50	1							
514— 539	526.50	2							
540— 565	552.50	1							
566— 591	578.50	7							
592— 617	604.50	4							
618— 643	630.50	3							
644— 669	656.50	2							
670— 695	682.50	0							
696— 721	708.50	0							
722— 747	734.50	0							
748— 773	760.50	0							
774— 799	786.50	1	2						
800— 825	812.50		0						
826— 851	838.50		3						
852— 877	864.50		2						
878— 903	885.50		7						
904— 929	916.50		4	1					
930— 955	942.50		3	1					
956— 981	968.50		1	2	1				
982—1,007	994.50			3	1				
1,008—1,033	1,020.50			2	2				3
1,034—1,059	1,046.50			3	6				2
1,060—1,085	1,072.50			5	5			4	6
1,086—1,111	1,098.50			4	2		2	0	2
1,112—1,137	1,124.50			1	1		3	4	3
1,138—1,163	1,150.50				1		3	6	3
1,164—1,189	1,176.50				1		4	2	2
1,190—1,215	1,202.50				1	1	3	4	0
1,216—1,241	1,228.50				0	1	3	0	0
1,242—1,267	1,254.50				1	1	2	0	1
1,268—1,293	1,280.50					3	1	2	
1,294—1,319	1,306.50					5	0		
1,320—1,345	1,332.50					2	0		
1,346—1,371	1,358.50					2	0		
1,372—1,397	1,384.50					3	0		
1,398—1,423	1,410.50					2	1		
1,424—1,449	1,436.50					1			
1,450—1,475	1,462.50					0			
1,476—1,501	1,488.50					0			
1,502—1,527	1,514.50					0			
1,528—1,553	1,540.50					1			
Total		22	22	22	22	22	22	22	22
Mean		592.682 ±8.924	884.000 ±6.707	1,038.227 8.003	1,079.591 9.497	1,336.045 ±10.697	1,241.864 ±12.072	1,155.258 ±8.258	1,100.764 ±8.355
Standard deviation		62.087 ±6.314	46.638 ±4.742	55.645 ±5.658	66.035 ±6.715	74.382 ±7.564	83.934 ±8.535	57.420 ±5.837	58.088 ±5.907
Coefficient of variability		10.488 ±1.078	5.274 ±0.536	5.359 +0.545	6.116 ±0.637	5.567 +0.566	6.739 ±0.687	4.970 ±0.505	5.295 ±0.538

CERTAIN STUDIES ON THE REMOVAL OF HUSK OF PILI NUTS (CANARIUM OVATUM ENGL. AND C. LUZONICUM (BLUME) A. GRAY[1]

PRIMO L. AUSTRIA

INTRODUCTION

Excluding the coconut, the pili nut, *Canarium ovatum* Engl., is perhaps the most important nut fruit of the Philippines. In addition to supplying the local market, the nuts are exported, mostly to France, Japan, Great Britain, and the United States.

According to an anonymous writer (1928)[2] the production in the Philippines of this important nut fruit amounted in 1924 to 4,405,600 kgm. In 1913, 1,186,173 kgm. valued at ₱188,270 were exported. From that year the exportation of this product decreased very markedly; in 1927 there were only about 22 kgm., valued at ₱37, exported. One of the causes of this decrease was the poor quality of the nuts; most of them were rancid when placed on the market. It is believed that this early rancidity of the nuts is mainly due to the method used in the removal of the husk. Hence, any contribution to the knowledge of removing the husk of the pili nut efficiently, without the treatment having any harmful effect on the viability of the kernel is important.

The writer could not find any literature directly related to the subject. The Philippine Census (1918)[3] gives data relative to the extent of the culture of the plant in the Philippines. An anonymous writer (1928) wrote upon "the pili nut industry" in the Philippines, giving the description of the plant, uses of the nut, and some statistics on the production and marketing of the fruit.

The method of removing the husk of pili nut generally used in pili nut growing regions consists in heating water in a large vat holding about 100 liters, and when the water is hot enough to scald the hand, sacks full of freshly gathered pili fruits are emptied into the vat. The water is kept hot and is stirred once in a while to keep the temperature uniform. The nuts are left in the water until the husk will come off easily when the fruit is pressed with the hand. When this point is reached the nuts are taken out and husked by hand at once. It is believed that if the water gets too hot the vitality of the kernel is lowered if the germ of the seed is not killed. If the nuts are left in the hot water much beyond the time when the husk can be removed easily it becomes difficult to get it off. In this case the nuts are opened without removing the husk. It is obvious that this kind of product is good only for home consumption.

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[1] Part of thesis presented for graduation, 1930, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 407; Experiment Station contribution No. 794. Prepared in the Department of Agronomy under the direction of Dr. Leon G. Gonzalez.

[2] Anonymous. 1928. The pili nut industry. Philippine Department of Commerce and Industry Journal **4**: 1–16.

[3] Anonymous. 1918. Census of the Philippine Islands. Vol. 3; Agriculture. Manila: Bureau of Printing.

Objects of the present study

The objects of these experiments were: (*a*) To find an efficient way of removing the husk of the pili nut; and (*b*) to determine the effects of the treatment on the keeping quality of the kernel.

Time and place of the present work

Inquiries on the practice of removing the husk by the farmers were made in the Bicol provinces. The experimental part of the work was done in the Agronomy Department of the College of Agriculture. The experiments were conducted from June 1928 to June 1929 and from January 1930 to October 1930.

MATERIALS AND METHODS

Materials used

In the present study the nuts used were gathered from seedling trees of the two important species of *Canarium;* namely, *C. ovatum* Engl. and *C. luzonicum* (Blume) A. Gray. The fruits were gathered when they became mature; this stage is indicated by the change in the color of the husk from green to purple. The fruits of the two species were mixed together, then divided into several lots and treated as the experiments required. The fruits were mixed so as to approach the conditions common in most pili nut groves and also to increase the experiment materials. As the nuts were well mixed before they were divided into lots it was felt that using the two species of *Canarium* would not affect appreciably the comparative results of the treatments. Furthermore, the results of a number of preliminary experiments show that nuts of these two varieties respond in much the same way to different treatments incident to the removal of the husk.

Methods used in removing the husk

Removal by hand. Two methods were used. In one the pulp was crushed by putting the nuts on a cement floor and pounding them with a piece of wood. The force was enough to break the pulpy covering but not enough to break the hard shell of the nut. In the other method, the husk was cut off with a knife. There were in all nine trials, three for the pounding method and six for the cutting method. In each trial 100 nuts were used. A total of 900 nuts were used in the experiments. The time it took to husk the nuts in each lot was recorded.

Retting in tap water. In this method kerosene cans were filled with tap water and the nuts put in them and left until the husk of the fruit came off easily. Nine lots of 100 nuts each were used.

Placing the nuts under the shade of a tree. In the third method the fresh pili nuts were placed on the ground under the shade of a tree. Ants, worms, and termites visited the place and ate part of the husk. The time it took the husk to rot completely was recorded.

Hot water treatments. In the fourth method the fruits were soaked in hot water until the husk could be removed easily. A kerosene stove was used for heating purposes. Five temperatures were used; namely, 40°, 50°, 60°, 70°, and 80°C. The duration of the experiment from the time the nuts were put in the hot water until the pulp could be easily removed was recorded.

Chemical treatments. The effects of 5 and of 10 per cent solutions of commercial potassium hydroxide and sulfuric acid were tried. The solutions were placed in museum jars of about 20 liters capacity and the fruits immersed in them. In some cases the same solution was used several times to determine the maximum action of the chemical. The duration of the experiment was carefully noted in each case.

The nuts prepared according to the different methods just described were properly labeled and placed in the laboratory for further observation. Some of them were treated for the catalase activity of the kernel, some were carefully cracked and the kernels planted to determine their viability and others were opened and tested for rancidity. The different observations varied from a few weeks to two years.

EXPERIMENTS AND RESULTS

Efficiency of the different methods used

The lots of 100 nuts selected at random and subjected to the different treatments were observed closely as to length of time before the husk softened and as to appearance of the prepared nuts. The details and the results are shown in table 1.

The influence of the treatments on the viability of the kernel

Using the germination test. The nuts were grouped according to the methods used in preparing them. From each of these groups, lots of ten nuts each were selected at random. These were carefully cracked and the kernels planted in seed boxes containing clean sterilized sand. These kernels were given the usual care. They were observed for germination of the kernel. The process was repeated several times at intervals of 14 days. The data and the results of the experiments are shown in table 2.

Determination of rancidity. There was some difficulty in checking the influence of the treatments given to the different lots of nuts as affected by the removal of the pulp. Although some of the kernels were apparently in a very fresh condition, they failed to germinate. The marketability of the nuts, however, was still unimpaired. Because of this apparent inconsistency another method of judging the freshness of the nuts was resorted to. It was noticed that a slight discoloration of the kernel preceded rancidity in the seed. This change in color became more marked as rancidity advanced. The nuts also had a very conspicuous oil-soaked appearance. In the later parts of the experiments, this behavior was taken as the criterion for judging the soundness of the kernels. The results of this experiment are shown in table 3.

DISCUSSION OF RESULTS

There are three important points to be considered in choosing a method for removing the husk of the pili nut, these are: the efficiency, the cost and the effect on keeping qualities. From the data given in table 1, it would seem that retting in water at 40° and 50°C. is the most practical method.

The time consumed in the operation and the cost are very reasonable and the effect on the keeping qualities of the kernel is negligible. With the hot water treatment there is a direct correlation between the increase in the temperature of the water used and the length of time it takes to remove the pulp. For instance, when the nuts were retted in ordinary tap water at about 28°C. it took from 14 to 32 hours before the pulp could be removed. Nine sets of experiments gave an average of 21.27 hours. In water heated to 40°C. the range was between 0.16 and 0.73 of an hour with an average of 0.55 for a group of experiments consisting of seven trials. At 50°C. with seven trials there was an average of 0.40 hour with a range of 0.15 and 0.58 hour. At 60°C. the range in seven trials was between 0.15 and 0.41 with an average of 0.28 hour. At 70°C. the average was further decreased to 0.21 hour with a range between 0.31 and 0.30. When the temperature was increased to 80°C. the length of time to soften the husk was still less with an average of only 0.12 hour, or 5 minutes.

The data as given in table 2 do not lead to a definite conclusion as to the influence of the treatment on the viability of the seeds. The apparent inconsistencies may be due to a number of reasons other than the effects of the treatment, as for example the influence of diseases and pests and differences in the condition of the growing media. As it is a direct measure of the quality of the nut, the rancidity test on the treated nuts six months after the treatment appears to be the best measure of the influence of the treatments. As stated elsewhere in this paper there may be sound nuts that will not germinate yet their commercial value may not be lowered. Judging from the rancidity test, it seems that the germinative power of the seed begins to be affected at 60°C. Table 3 shows that 56 per cent of the nuts soaked in water at 60°C. even for a short time, when opened, were spoiled. At higher temperatures, all the nuts were rancid at the end of six months. In the other treatments, at the end of a year only a few nuts were spoiled.

It is important to note the influence of high temperature during the removal of the husk. There is an optimum time at which the husk can be removed easily. With longer soaking at the same temperature, the husk became so hard that it could be removed only with difficulty.

Of the different treatments employed, perhaps the most expensive is removing the pulp with a knife. Except for points of comparison this method need not be considered further. The treatment with chemicals is also expensive. It would cost 28 centavos to treat 1,000 nuts with commercial sulfuric acid and 56 centavos to treat them with potassium hydroxide. These costs are calculated on the basis of using the same solution three times. There is one advantage from the viewpoint of marketing in treating the nuts with chemicals, and that is the attractive appearance. The nuts treated with sulfuric acid were light pink, and those treated with potassium hydroxide were light gray in color. Pili nuts ordinarily found in the market are light brown.

The nuts placed under a tree to rot the husk off were so badly discolored that it is doubtful if they would have any market value at all.

The fact that none of the nuts soaked in water at 40° and 50°C. were rancid at the end of 6 months and only a few were spoiled at the end of a year, shows that the treatment, although it may tend to devitalize the seeds, is a satisfactory treatment of the nuts for commercial preparation.

SUMMARY AND CONCLUSIONS

1. Six methods of removing the husk were used; namely, pounding by hand, cutting the husk off with a knife, retting in tap water, soaking in hot water, placing under shade, and treatment with chemicals.

2. Soaking in water at 40° to 50°C. was the most practical of all the methods used and is recommended for general use. Below this temperature the time it took to remove the husk was greatly lengthened; above this temperature the nuts in storage became rancid in a short time, the higher the temperature the shorter the time. At 80°C. the germ was killed and the kernel became rancid in about a month. At 60°C. about 50 per cent of the nuts were rancid after 6 months; while nuts treated with 40° and 50°C. remained in a good condition for about a year or even longer.

3. Removing the pulp with a knife or pounding it with wood are expensive treatments.

4. Under the conditions of this investigation, allowing the husk to decay and fall off in the shade is not to be recommended as it takes a long time and particularly because the nuts become seriously discolored.

5. Treatment with 5 and 10 per cent solutions of sulfuric acid and potassium hydroxide are equally effective; the husked nuts are quite attractive, but the cost of the chemicals is rather high. These solutions may be used for polishing the nuts after the hot water treatment to improve their color.

6. Germinating the kernels to test the influence of the different treatments of the nuts in removing the husk did not give conclusive results. A few of the nuts were naturally non-germinable and significant sources of error caused by diseases and pests were not altogether eliminated in these experiments.

7. Examination by inspection and tasting for rancidity of the kernel proved more satisfactory. Rancid nuts and those beginning to be rancid had an oil-soaked appearance.

TABLE 1

Different methods used and time required for removing the husk from pili nuts

METHODS USED	DATE	TRIALS	TIME REQUIRED TO REMOVE HUSK FROM 100 NUTS	
			hours	*hours*
Knife	Aug. 26, 1928	Trial 1	5	
	Aug. 27, 1928	“ 2	4.5	
	Aug. 27, 1928	“ 3	4.1	
	Aug. 29, 1928	“ 4	5.5	4.53 av.
	Aug. 29, 1928	“ 5	4.2	
	Aug. 29, 1928	“ 6	3.9	
Pounded with a piece of wood	April 9, 1930	Trial 1	1.33	
	April 14, 1930	“ 2	1.80	1.51 av.
	May 13, 1930	“ 3	1.40	
Placed under shade	Aug. 1, 1928	Trial 1	240	
	Aug. 2, 1928	“ 2	216	
	Aug. 3, 1928	“ 3	235	
	Aug. 18, 1928	“ 4	360	
	Aug. 19, 1928	“ 5	408	268.55 av.
	Aug. 21, 1928	“ 6	390	
	Aug. 16, 1930	“ 7	264	
	April 19, 1930	“ 8	160	
	May 7, 1930	“ 9	144	
Retted in tap water (25°C.—28°C.)	Aug. 23, 1928	Trial 1	15.5	
	Aug. 23, 1928	“ 2	14	
	Aug. 25, 1928	“ 3	15	
	Aug. 28, 1928	“ 4	20	
	Aug. 29, 1928	“ 5	22	21.27 av.
	Aug. 30, 1928	“ 6	27	
	April 10, 1930	“ 7	21	
	April 14, 1930	“ 8	32	
	April 19, 1930	“ 9	25	
Soaked in water heated to 40°C.	Aug. 26, 1928	Trial 1	.53	
	Aug. 27, 1928	“ 2	.58	
	Aug. 29, 1928	“ 3	.53	
	Sept. 8, 1928	“ 4	.70	.55 av.
	Sept. 8, 1928	“ 5	.73	
	Sept. 8, 1928	“ 6	.66	
	April 8, 1930	“ 7	.16	
Soaked in water heated to 50°C.	Sept. 8, 1928	Trial 1	.55	
	Sept. 8, 1928	‘ 2	.50	
	Sept. 8, 1928	“ 3	.58	
	Sept. 19, 1928	“ 4	.33	.40 av.
	Sept. 29, 1928	“ 5	.38	
	Sept. 30, 1928	“ 6	.33	
	April 8, 1930	“ 7	.15	

TABLE I (Continued)

METHODS USED	DATE	TRIALS	TIME REQUIRED TO REMOVE HUSK FROM 100 NUTS	
			hours	*hours*
Soaked in water heated to 60°C....	Aug. 23, 1928	Trial 1	.25	.28 av.
	Aug. 24, 1928	" 2	.31	
	Aug. 24, 1928	" 3	.20	
	Sept. 10, 1928	" 4	.41	
	Sept. 10, 1928	" 5	.38	
	Sept. 10, 1928	" 6	.30	
	April 8, 1930	" 7	.15	
Soaked in water heated to 70°C...	Aug. 24, 1928	Trial 1	.18	.21 av.
	Aug. 25, 1928	" 2	.20	
	Aug. 25, 1928	" 3	.15	
	Sept. 10, 1928	" 4	.25	
	Sept. 10, 1928	" 5	.28	
	Sept. 10, 1928	" 6	.30	
	April 8, 1930	" 7	.13	
Soaked in water heated to 80°C....	Aug. 25, 1928	Trial 1	.11	.12 av.
	Aug. 27, 1928	" 2	.13	
	Aug. 27, 1928	" 3	.11	
	April 8, 1930	" 4	.13	
Soaked in 5 per cent solution of potassium hydroxide...	Aug. 31, 1928	Trial 1	12.6	17.25 av.
	Aug. 31, 1928	" 2	12.4	
	Aug. 31, 1928	" 3	12	
	Sept. 3, 1928	" 4	14	
	Sept. 9, 1928	" 5	16.3	
	Sept. 10, 1928	" 6	17.3	
	April 10, 1930	" 7	15.6[a]	
	April 13, 1930	" 8	24 [b]	
	April 17, 1930	" 9	30 [c]	
	April 22, 1930	" 10	10.6[a]	
	May 2, 1930	" 11	25 [b]	
Soaked in 10 per cent solution of potassium hydroxide.............	Aug. 31, 1928	Trial 1	7	13.38 av.
	Aug. 31, 1928	" 2	8	
	Aug. 31, 1928	" 3	7	
	Sept. 4, 1928	" 4	10	
	Sept. 4, 1928	" 5	9.1	
	Sept. 5, 1928	" 6	11.2	
	Sept. 9, 1930	" 7	11.3[a]	
	April 12, 1930	" 8	26 [b]	
	April 15, 1930	" 9	30 [c]	
	April 22, 1930	" 10	6.6[a]	
	May 2, 1930	" 11	21 [b]	

TABLE 1 (Continued)

METHODS USED	DATE	TRIALS	TIME REQUIRED TO REMOVE HUSK FROM 100 NUTS	
			hours	*hours*
Soaked in 5 per cent solution of sulfuric acid.....	Sept. 5, 1928	Trial 1	9.8	
	Sept. 5, 1928	" 2	10	
	Sept. 5, 1928	" 3	10	
	Sept. 5, 1928	" 4	12	
	Sept. 5, 1928	" 5	10	
	Sept. 5, 1928	" 6	12.5	13.90 av.
	April 10, 1930	" 7	13.5[a]	
	April 16, 1930	" 8	20[b]	
	April 19, 1930	" 9	26[c]	
	April 22, 1930	" 10	8.1[a]	
	May 2, 1930	" 11	21[b]	
Soaked in 10 per cent solution of sulfuric acid.....	Sept. 6, 1928	Trial 1	7.5	
	Sept. 6, 1928	" 2	8	
	Sept. 6, 1928	" 3	8	
	Sept. 10, 1928	" 4	9	
	Sept. 10, 1928	" 5	8	13.22 av.
	Sept. 10, 1928	" 6	10	
	April 10, 1930	" 7	12[a]	
	April 13, 1930	" 8	20[b]	
	April 16, 1930	" 9	32.6[c]	
	April 22, 1930	" 10	6.4[a]	
	May 2, 1930	" 11	24[b]	

[a] 1st use of the solution.
[b] 2nd use of the solution.
[c] 3rd use of the solution.

TABLE 2

The influence of various treatments on the germinative power of pili nuts

METHOD OF HUSKING USED	PERCENTAGE OF GERMINATION			
	First planting	Second planting	Third planting	Average of 3 plantings
Pounded with a piece of wood.........	50	50	40	46.66
Placed under shade..................	90	90	70	83.33
Retted in tap water (25°C.—28°C.)....	50	50	50	50.00
Soaked in water heated to 40°C.	80	70	60	70.00
Soaked in water heated to 50°C.	20	60	40	40.00
Soaked in water heated to 60°C.	10	10	10	10.00
Soaked in water heated to 70°C.	0	0	0	——
Soaked in water heated to 80°C.	0	0	0	——
Soaked in 5 per cent solution of potassium hydroxide..................	70	90	60	73.33
Soaked in 10 per cent solution of potassium hydroxide..................	70	30	50	50.00
Soaked in 5 per cent solution of sulfuric acid............................	50	80	80	70.00
Soaked in 10 per cent solution of sulfuric acid............................	40	70	70	60.00

TABLE 3

The influence of various treatments on the keeping quality of the kernel of pili nuts

METHODS OF HUSKING USED	DATE OF TREATMENT	DATE OF EXAMINATION	CONDITION OF KERNELS OF PILI NUTS		
			Good	Rancid	Rancid
	1930	*1930*	*number*	*number*	*per cent*
Pounded with a piece of wood.	April 9	Oct. 14	48	1	2.04
	April 14	Oct. 14	68	0	0.00
	April 13	Oct. 14	63	2	3.07
Placed under shade	April 16	Oct. 14	37	3	7.50
	April 19	Oct. 14	74	2	2.60
	May 7	Oct. 14	86	0	0.00
Retted in tap water (25°C.—28°C.)	April 10	Oct. 14	37	2	5.12
	April 14	Oct. 14	53	4	7.01
	April 19	Oct. 14	78	0	0.00
Soaked in water heated to 40°C.	April 8	Oct. 14	32	0	0.00
Soaked in water heated to 50°C.	April 8	Oct. 14	40	0	0.00
Soaked in water heated to 60°C.	April 8	Oct. 14	10	13	56.52
Soaked in water heated to 70°C.	April 8	Oct. 14	0	80	100.00
Soaked in water heated to 80°C.	April 8	Oct. 14	0	92	100.00
Soaked in 5 per cent solution of potassium hydroxide	April 10	Oct. 14	38	0	0.00
	April 13	Oct. 14	44	0	0.00
	April 17	Oct. 14	65	0	0.00
	April 22	Oct. 14	44	0	0.00
	May 2	Oct. 14	62	0	0.00
Soaked in 10 per cent solution of potassium hydroxide	April 9	Oct. 14	39	0	0.00
	April 12	Oct. 14	21	0	0.00
	April 15	Oct. 14	45	0	0.00
	April 22	Oct. 14	50	0	0.00
	May 2	Oct. 14	57	0	0.00
Soaked in 5 per cent solution of sulfuric acid	April 10	Oct. 14	22	0	0.00
	April 16	Oct. 14	44	0	0.00
	April 19	Oct. 14	54	0	0.00
	April 22	Oct. 14	62	0	0.00
	May 2	Oct. 14	68	0	0.00
Soaked in 10 per cent solution of sulfuric acid	April 10	Oct. 14	44	0	0.00
	April 13	Oct. 14	22	0	0.00
	April 16	Oct. 14	31	0	0.00
	April 22	Oct. 14	46	0	0.00
	May 2	Oct. 14	53	0	0.00

A STUDY ON THE EFFICIENCY OF THE DIFFERENT METHODS FOR CONTROLLING STOMACH AND INTESTINAL WORMS IN SHEEP AND GOATS[1]

PERFECTO C. BONCATO

Undoubtedly, in the Philippines, sheep and goats suffer more from internal parasites than from any other ailment. Affected animals either die or remain thin when they are heavily infested. Sheep and goats of any age may harbor these organisms but the heaviest infestations are usually observed among lambs and kids.

Piao and Gibbs (1927)[2] state that copper sulfate solution is not as effective for controlling stomach worms in sheep as in goats. They claim to have found a mixture of nicotine and copper sulfate solutions that gives better results than copper sulfate alone. According to Bell and Warwick (1928)[3] copper sulfate solution given at intervals of four weeks is an effective means of controlling losses from sheep infested with stomach worms. These authors also state that at the Oklahoma and Ohio Stations a high plane of nutrition was helpful in making the animals not only able to withstand the attack of parasites but to make gains.

The object of the work reported in this paper was to determine the efficacy of the different methods of controlling internal parasites in sheep and goats under Los Baños conditions by subjecting them to the following kinds of treatment: First, by giving the animals a liberal supply of concentrate as supplemental feed; second, by administering to them copper sulfate solution; third, by drenching them with a mixture of copper sulfate and nicotine solutions.

This work was conducted at the College of Agriculture, University of the Philippines, from August 20, 1928 to January 31, 1930, covering a period of over one year and five months.

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[1] Thesis presented for graduation, 1930, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 408; Experiment Station contribution No. 795. Prepared in the Department of Animal Husbandry under the direction of Dr. Valente Villegas.

The writer wishes to acknowledge his indebtedness to Doctors Tubangui and Mondoñedo for help extended in the examination of the feces of the animals for the eggs of parasites.

[2] Piao, Sheo, and C. S. Gibbs. 1927. The control of stomach worm in the goats. The Lingnaam Agric. Rev. **4**: 20–26.

[3] Bell, D. S., and B. L. Warwick. 1928. Control of stomach worms in sheep. Ohio Agric. Exper. Sta. Bull. 13: 92–98. *Fig. 1–5.*

MATERIALS

Animals

In all, 32 animals were used in this experiment, of which 12 were sheep and 20 were goats. The sheep were all of Indian blood; the goats had Nubian blood in different proportions. The goats in experiment I were each about nine months old (275-284 days) except those in lot IV which averaged about one and one-half years (479-583 days). Most of the goats in experiment II were about eight months old. The animal in lot I was over two months old (70 days); one in lot III was over one month old (33 days); one of the animals in lot IV was about four months old (116 days). Excepting those in lot I of experiment I which averaged over three years and eight months of age, the sheep varied in age from two to seven months (53-215 days). The sheep in experiment II ranged in age from three to nine months (111-270 days).

Grain feeds

The standard mixture of grain used for milking does at the College was used in feeding the animals in the lots which received grain supplement. This grain mixture was eight parts, by weight, of corn, five parts of copra meal and one part of rice bran.

Medicinal preparations

The copper sulfate solution used in this work was made by dissolving 56.7 grams of blue copper sulfate crystals in 3.8 liters of water, making the strength of the solution 1.47 per cent, by weight. The nicotine-copper sulfate solution was of the same strength of copper sulfate solution as that above mixed with an equal volume of nicotine solution. The nicotine solution was prepared by steeping 113.4 grams of powdered tobacco in 946 cubic centimeters of water for ten to twelve hours; the clear liquid was obtained from the solution by filtering. The solution had a strength of 10.7 per cent, by weight.

METHODS

Allotment

This investigation was run in two sets, experiments I and II. The same conditions as to treatment and management of the animals were followed in both trials, the main difference being in the season in which each experiment was carried on and the frequency with which the anthelmintics were given. Experiment I was run from August 20, 1928 to June 9, 1929 covering a period of 294 days. Experiment II was run from June 9, 1929 to January 27, 1930, covering a period of 233 days. The purpose of running experiment

II was to verify the results that were obtained in experiment I. Under each experiment there were four lots as follows:

Lot I, no treatment (control).
Lot II, with grain supplement.
Lot III, treated with copper sulfate solution.
Lot IV, treated with copper sulfate and nicotine solution.

In experiment I there were two sheep and two goats in each lot. In experiment II, (as shown in table 2) there were three goats and one sheep in each lot. In alloting the animals, care was exercised so that the distribution of age and sex of the animals was as uniform as possible. The less thrifty-looking individuals were placed in lots which were to receive medicinal treatment.

Frequency of treatment

Grain was given to animals in lot II of experiments I and II every evening in amounts that they would consume readily at each feeding. During the 294 days that experiment I was run, 182 kgm. of the grain mixture was consumed, the average amount of feed eaten by each animal being 0.3 kgm. a day. In experiment II the animals consumed a total amount of 126 kgm. making an average consumption of 0.18 kgm. a day per animal. Under experiment I, animals in lots III and IV were given anthelmintic treatment every week. Those of the same lots in experiment II were treated every three weeks.

Dosage

The dosages of the solution of copper sulfate and copper sulfate and nicotine solutions were as follows:

For lambs and kids 3 months old	20 cc.
For lambs and kids 6 months old	40 cc.
For yearlings	60 cc.
For lambs and kids over 2 years old	90 cc.

Based on the amounts of solution, the animals in the copper sulfate solution lot received the following quantities of the drug; animals three months old, 0.29 gram, animals six months old, 0.58 gram, yearlings, 0.88 gram, animals over 2 years old, 1.32 grams. Those that received copper sulfate and tobacco got the following amounts of the substance: animals three months old, copper sulfate, 0.14 gram, tobacco, 1.07 grams; animals six months old, copper sulfate, 0.29 gram, tobacco, 2.14 grams; animals two years old, copper sulfate, 0.66 gram, tobacco, 3.21 grams.

The lambs and kids to be drenched with the anthelmintic solution were kept away from feed and water for about eighteen hours before and six hours after treatment. The copper sulfate solution was kept free from crusts or any white precipitate before giving it to the animal. It was mixed thoroughly and the doses measured accurately to prevent over-dosing. Drenching was done while the animal was in a standing position. The head was held on a horizontal plane and if the animal coughed while the liquid was being poured, the head was lowered. It was found that a satisfactory way to control the animal was to back it up in a corner, its head being restrained by the two legs of the operator who straddled over the neck of the animal. The solution was given as soon as the animal had been quieted.

General management of the animals

All the animals in these experiments were allowed to run with the main herd. They had access to a variety of vegetation in the pasture in the daytime. So far as possible the animals were rotated in the different pastures to prevent the rapid multiplication of parasites in any place. At night the animals were quartered in a barn which was kept clean.

Examination of feces for the eggs of parasites

The method employed by Hall (1912)[4] in the examination of the feces for the eggs of parasites was followed in part in this work. In the evening before the day the feces were to be collected, the animals were placed in separate pens, whereby samples of manure from each animal were obtained. The feces samples were collected in the morning. A ten per cent solution of formalin was used to preserve the feces but in the majority of cases the material was examined for the eggs of parasites soon after collection, in which cases the use of preservative was dispensed with. Ten per cent solution of formalin was prepared by diluting 10 cc. of formalin (40 per cent strength) to a volume of 100 cc. As a preliminary step to the examination of the eggs of the parasites under the microscope, it was necessary to break up or crush the feces by means of a stirring rod. The small particles obtained were then passed through a brass sieve with 36 meshes to the linear centimeter (or 91 meshes to one inch). Sieving was done two or three times in each case to collect as much as was possible of the eggs of parasites which passed through the meshes leaving behind large particles of foreign substances. After working with one sample, the sieve was washed thoroughly using a stiff brush so that in sieving other fecal specimens they might not be contaminated with the eggs in the previous samples. The material that passed through the sieve was then mixed with water and sedimented in a test tube. After decanting the supernatant liquid, the sediment was transferred into a centrifuge tube. The material was afterwards centrifuged at the rate of 3500 revolutions per minute for from five to ten seconds. Following this, the sediment remaining at the bottom of the tube was examined by drawing up from the bottom of the tube with a pipette a drop of the sediment. The material was placed on a slide and covered by a cover glass before examining it under the microscope. Five different areas of the sample were focused under the microscope and the average of five readings was taken as the egg count of the sample in question. The pipette used was rinsed thoroughly with clean water each time it was used to prevent the contamination of the next sample to be examined.

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[4] Hall, M. C. 1912. A comparative study of methods of examining feces for evidences of parasitism. U. S. Dept. Agric. Bur. Animal Indus. Bull. 135: 1–42. *Fig. 1.*

Post-mortem examination

All the animals that died during the progress of the experiment were subjected to post-mortem examination, particular attention being given to the identification of the parasites found and to the degree of infestation. Two living animals were purposely slaughtered at the end of the experiment to determine the extent of infestation as related to other findings made during the experiment.

DISCUSSION OF RESULTS

Experiment I

As may be seen in table 1, all the goats in the different lots increased in weight during the experiment. There was hardly any difference in weight that may be accounted for by the treatment the different animals received. In lot III, animals, Herd Nos. 196 and 197 were unthrifty throughout the test, hence made little gain.

The sheep in the same experiment also gained in weight during the investigation. As with the goats, there was no significant difference in the increase made by any one lot over another that denoted any influence of the treatment.

The egg count of parasites among goats in experiment I showed that the animals in lot I were the most heavily infested. Goats in lot II appear to show a decreasing number of eggs as the period of the investigation advanced, indicating the favorable influence of grain feeding in lowering the degree of infestation of the animals. The weekly egg count in lot III seems to indicate some improvement resulting from the treatment of the animals with the copper sulfate solution. The goats that received the copper sulfate-nicotine solution did not show even a slight degree of improvement as judged by the egg count from the beginning to the end of the trial. This result is contrary to that obtained by Piao and Gibbs (1927) in which this solution is claimed to have given the best results.

Among the sheep, lot I showed a slight infestation due possibly to the advanced age of the animals. The effect of grain feeding in lot II and the administration of anthelmintics in lots III and IV is practically the same in reducing the degree of infestation of the animals towards the latter part of the experiment. These statements, however, cannot be considered conclusive as they are based on very small differences in the number of egg counts in the different lots.

TABLE 1

Herd number, breeding, sex, age, gain in weight and duration of experiment

Experiment I

HERD NO.	BREEDING	SEX	AGE	GAIN IN WEIGHT	DURATION OF EXPERIMENT
			days	*kgm.*	*days*
		Goats			
Lot I					294
202	Nubian grade	Female	275	8.18	
203	Nubian grade	Female	275	8.63	
Lot II					
193	Nubian grade	Female	284	6.81	
195	Nubian grade	Female	283	11.09	
Lot III					
196	Nubian grade	Female	283	3.86	
197	Nubian grade	Female	283	0.54	
Lot IV					
175	Nubian grade	Female	583	8.13	
185	Nubian grade	Female	479	9.18	
		Sheep			
Lot I					294
5	Indian grade	Female	1979	12.25	
29	Indian grade	Female	730	5.81	
Lot II					
41	Indian grade	Female	96	9.95	
44	Indian grade	Female	62	13.95	
Lot III					
42	Indian grade	Male	53	7.50	
43	Indian grade	Male	62	13.95	
Lot IV					
36	Indian grade	Female	215	5.68	
37	Indian grade	Male	211	0.16	

Experiment II

It would seem from the foregoing discussion that the method used of sampling feces is either not an accurate means of determining the degree of parasitism in the intestinal canal, or the eggs of some worms other than stomach worms were included in these counts, or the operation of both conditions were at work. Fortunately, the results obtained in experiment II have enabled the writer to clear up some of these points.

It may be seen in table 2 that all the goats survived to the end of the experiment only in lot II. They registered an average gain in weight of 1.5 kilograms each. These animals received grain supplement. Two of the goats which were treated with copper sulfate solution also lived and made an average gain of 0.6 kilogram in weight. Of those in lot IV which were treated with copper sulfate-nicotine solution only one animal lived, the gain in weight being 1.4 kilograms. One animal in this lot was accidentally gored by another goat and died.

TABLE 2

Herd number, breeding, sex, age, gain in weight, duration of the experiment

Experiment II

HERD NO.	BREEDING	SEX	AGE	GAIN IN WEIGHT	DURATION OF EXPERIMENT
			days	*kgm.*	*days*
		Goats			
Lot I					
221	Nubian grade	Male	249	——	233
253	Nubian grade	Female	70	——	
240	Nubian grade	Female	165	——	
Lot II					
237	Nubian grade	Male	271	1.59	
231	Nubian grade	Female	242	0.90	
235	Nubian grade	Female	266	1.81	
Lot III					
214	Nubian grade	Male	253	0.90	
234	Nubian grade	Female	270	0.45	
254	Nubian grade	Female	38	——	
Lot IV					
230	Nubian grade	Male	247	——	
236	Nubian grade	Female	256	1.36	
242	Nubian grade	Female	116	——	
		Sheep			
Lot I					
46	Indian grade	Male	125	——	233
Lot II					
49	Indian grade	Female	162	0.68	
Lot III					
45	Indian grade	Female	111	2.45	
Lot IV					
48	Indian grade	Female	270	——	

Similar results were obtained with sheep. The animals in lot I, which did not receive any treatment, died from parasitic infestation. The sheep in lots II and III lived and showed 0.7 kilogram gain in the first lot and 2.5 kilograms in the second. In lot IV the animal died of parasitic infestation.

In the number of eggs in the feces of the animals in the different lots, there was a general agreement with the results obtained in experiment. That is, the untreated lots of both goats and sheep appeared to be heavily infested; the lot receiving a supplementary feed (lot II) showed some improvement over lot III; but lot IV showed no improvement over lot III and certainly was not much better than lot I.

Autopsy report

Altogether six goats died during the experiment, among which was Herd No. 230 which died from results of an accident. Three sheep also died during the trial. All of them belonged to experiment II. No animals died in experiment I. Whether the mortality in experiment II was due to the effect of parasitism aggravated by the rainy season during which this experiment was carried out cannot be ascertained. The fact that all animals in experiment I lived might be ascribed to the apparently better climatic conditions for sheep and goats during the dry season when the experiment was conducted, but no definite assertion can be made.

Direct examination of the digestive tract of the animals that were subjected to a post-mortem examination showed the presence of three kinds of worms; namely, stomach worm (*Haemonchus contortus*), hookworm (*Bunostomum* spp.) and tapeworm (*Moniezia expansa*). All of the goats had stomach worms except Herd Nos. 242 and 230. Hookworms were found in all the sheep and the goats. No post-mortem examination was made of the sheep Herd No. 48. There were three goats (Herd Nos. 221, 240 and 242) that were found to be infested with tapeworms, and a sheep (Herd No. 46) was also affected by the same parasite.

TABLE 3

Kinds of worms found in the alimentary tract on post-mortem examination of sheep and goats

HERD NO.	DATE OF DEATH	STOMACH WORM	HOOKWORM	TAPEWORM
		Goats		
254	VIII–20–29	Positive	Positive	None
242	IX – 3–29	None	Positive	Positive
221	IX –17–29	Positive	Positive	Positive
253	IX –29–29	Positive	Positive	None
240	X –23–29	Positive	Positive	Positive
230	X –17–29	None	Positive	None
		Sheep		
46	IX –20–29	Positive	Positive	Positive
45	I –27–29	Positive	Positive	None

In the alimentary tracts of the two healthy goats from lots II and III that were slaughtered, stomach worms, nodular worms (*Oesophagostomum columbianum*) and hookworms were found. From goat, Herd No. 237, in the grain-fed lot, two stomach worms, a few hookworms and numerous nodular worms were found. From goat, Herd No. 214, in the copper sulfate lot, 43 stomach worms, a few hookworms and numerous nodular worms were collected. Again, the grain-fed animal was only slightly infested with stomach worms while the copper sulfate animal showed a much larger number. From these findings it seems conclusive, that copper sulfate, or the mixture of copper sulfate and nicotine were not specific agents in controlling stomach worms, in amounts and in the frequency of administration given in these experiments. The favorable results from use of the drug reported by other investigators may probably be explained in some other way rather than as its specific effect on the parasite. It also appears definitely that grain alone gave better results than the use of copper sulfate.

SUMMARY OF CONCLUSIONS

1. The sheep and goat flocks of the College of Agriculture, University of the Philippines, were heavily infested with internal parasites.

2. The different parasites found in the alimentary tract of the animals were stomach worm (*Haemonchus contortus*) nodular worm (*Oesophagostomum columbianum*,) hookworm (*Bunostomum* spp.) and tapeworm (*Moniezia expansa*).

3. Animals given a mixture of grain in the proportion of eight parts, by weight, of shelled corn, five parts of copra meal, one part of rice bran, in amount that the animals would clean up readily every evening showed the best results in promoting good health and in reducing the parasitic infestation of the animals.

4. Copper sulfate solution in the doses used, administered to goats and sheep at weekly and 21-day intervals, was not as satisfactory as grain feeding in reducing the degree of infestation of the animals. Under unfavorable conditions, this anthelmintic is not very effective in controlling losses from the attack of internal parasites.

5. Neither did the copper sulfate-nicotine solution of the doses employed and in the frequency of treatment followed give as good results as grain feeding in lowering the degree of infestation of goats and sheep and in preventing losses from the parasites.

6. On the basis of egg count of parasites in the feces both copper sulfate and copper sulfate-nicotine solutions had similar effects in reducing the degree of infestation of sheep and goats.

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: IX[1]

B. M. GONZALEZ
Dean, College of Agriculture

Once each year we pause in our labors to set a marker by way of measure of the work accomplished during the year. The present list contains the output of the College of Agriculture during the academic year 1931-1932. In so far as it is an agency for the discovery of agricultural knowledge, the College has ceased to be experimental and has turned practical, in that it can now be depended upon to produce with great regularity scientific agricultural facts.

Whether by well-meaning critics or otherwise, the College faculty has often been dubbed as made up of theoretical day dreamers, meaning thereby, impractical. Recently, the writer had occasion to visit a stock farm and one such well-meaning critic looking at the stock quoted his colleague in charge of the work, stating that he reckoned the best that could be expected from that breed was six liters of milk a day. Thereupon a member of the faculty of the theoretical College remarked that the best animals of that breed his College possessed gave not more than five liters of milk a day, and he thought that was all that could be expected from that herd, and that the average for a full lactation period would be from two to three liters a day. The practical man did not have his facts, the theoretical man had them. The first man being practical worked with estimates, the second had his figures.

So it is with agricultural knowledge in general—the common farmer works empirically, drawing out of his experience variously affected by unweighed and oftentimes unrecognized variable factors The agricultural scientist studies his modifying factors one by one and records the effects of each, so that upon a correct analysis of a given situation he can foretell with considerable certainty forthcoming results.

It is the concern of the College of Agriculture and its Experiment Station to gradually reduce into science current agricultural practice and to discover facts that will make agriculture less of an adventure and more of a certainty. The work herein reported marks a stride in this direction.

II. EXPERIMENT STATION CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1-199, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, 1923. For Nos. 200-287,

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[1] General contribution from the College of Agriculture No. 307.

see THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 288-354, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 355-440, *see* THE PHILLIPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 441-517 *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 518-595, *see* THE PHILLIPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 596-643, *see* THE PHILLIPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 644-710, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931.

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(744) Gonzalez, L. G. 1931. A study of the respiration of the chico, *Achras zapota* Linn. The Philippine Agriculturist **20**: 341–348. *Fig. 1.*

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III. GENERAL CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos 1-104, *see* The Philippine Agriculturist XII, No. 7, December, 1923. For Nos. 105-141, *see* The Philippine Agriculturist XIII, No. 10, March, 1925. For Nos. 142-164, *see* The Philippine Agriculturist XIV, No. 10, March, 1926. For Nos. 165-184, *sse* The Philippine Agriculturist XV, No. 10, March, 1927. For Nos. 185-203, *see* The Philippine Agriculturist XVI, No. 10, March, 1928. For Nos. 204-216, *see* The Philippine Agriculturist XVII, No. 10, March, 1929. For Nos. 217-266, *see* The Philippine Agriculturist XIX, No. 2, July, 1930. For Nos. 267-288, *see* The Philippine Agriculturist XIX, No. 10, March, 1931.

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(308) Gonzalez, B. M. 1932. Published contributions of College of Agriculture: IX. The Philippine Agriculturist **20**: 678–685.

IV. CIRCULARS

The circulars are numbered serially as reported. For Nos. 1-5, *see* The Philippine Agriculturist XIV, No. 10, March, 1926. For Nos. 6-11, *see* The Philippine Agriculturist XV, No. 10, March, 1927. For Nos. 12-14, *see* The Philippine Agriculturist XVI, No. 10, March, 1928. For Nos. 15-16, *see* The Philippine Agriculturist XVII, No. 10, March, 1929. For Nos. 17-18, *see* The Philippine Agriculturist XIX, No. 2, July, 1930.

No. 19.—Cole, Anne F. 1931. A pageant: Illustrating the history and growth of the College of Agriculture. (Mimeographed).

No. 20.—Santos, F. O., and S. J. Ascalon. 1931. Amount of nutrients in Philippine food materials. (*See* Experiment Station contribution No. 753.)

No. 21.—Mendiola, Nemesio B. 1931. Cassava growing and cassava starch manufacture. (*See* Experiment Station contribution No. 758.)

V. MISCELLANEOUS CONTRIBUTIONS

(From outside the College of Agriculture and translations)

(1) Pendleton, Robert L. 1931. Contribution to the knowledge of the operation of crystallizers: II. Translation of "Bijdrage tot de Kennis der Koeltrogwerking;

Tweede mededeeling. Mededeelingen van het Proefstation voor de Java—suiker-industrie" by Dr. Ir. P. Honig and W. F. Alewyn. Sugar News **12**: 302–314. *Fig. 1–6;* 363–370; 497–505.

(2) UICHANCO, LEOPOLDO B. 1931. Historical notes on the cultivation of wheat in the Philippines. Translation of "Nota histórica sobre el cultivo del trigo en Filipinas." By Rev. Miguel Selga, S.J. The Philippine Agriculturist **20**: 239–245.

(3) UICHANCO, LEOPOLDO B. Father Francisco Ignacio Alzina, S.J. Translation from Spanish of article by Rev. Miguel Selga, S. J. The Philippine Agriculturist **20**: 367–369.

(4) UICHANCO, LEOPOLDO B. 1931. On the palms which are called cocos and their great usefulness. Translation of chapter on coconuts from "Historia natural del sitio fertilidad y calidad de las islas é indios de Visayas." (Unpublished manuscript written in 1668 by Father Francisco Ignacio Alzina, S. J.) The Philippine Agriculturist **20**: 435–446.

(5) UICHANCO, LEOPOLDO B. 1932. On another kind of bananas, which although it does not yield food for the natives, provides clothing. Translation of chapter on abacá from "Historia natural del sitio fertilidad y calidad de las islas é indios de Visayas". (Unpublished manuscript written in 1668 by Father Francisco Ignacio Alzina, S. J.) The Philippine Agriculturist **20** : 495–499.

(6) SULIT, MAMERTO D. 1932. Native methods of preparing namí (*Dioscorea hispida* Dennst.) tuber for food. The Philippine Agriculturist **20**: 637–641. *Fig. 1–3.* (Of Bureau of Forestry).

NOTE: SHOULD NEW SUGAR-CANE VARIETIES BE PATENTED[1]

Judging from letters which have reached the College of Agriculture, it seems certain that in the coming world convention of sugar technologists in Porto Rico many things will be discussed which are of vital relation to the sugar cane industry in the Philippines. One of these is the necessity and practicability of patenting new sugar cane varieties. It is hoped that the plan to send delegates from the College of Agriculture to this important convention will materialize.

Being a member of the Committee on Varieties of the International Society of Sugar Cane Technologists I received from Doctor Venkatraman, the Committee's chairman, the following questionnaire which was prepared by Doctor Posthumus of the Sugar Cane Experiment Station, Pasoeroean, Java, who intends to lead in the discussion of the question of patenting new cane varieties. My answers are here given with the questionnaire:

1. *Question.—Do you feel the desirability of fixing rights of property upon certain cane varieties in the same way as upon industrial inventions and discoveries? Is this already practicable in your country by existing laws?*

   Answer.—No. I am afraid it would be hard and costly to enforce any law fixing such rights. In the Philippines there are no laws which fix property rights upon cane varieties.

2. *Do you think the means of identification for cane varieties sufficiently conclusive in case of doubt or evasion?*

   Yes, if the right and duty to identify are vested in a group of competent technical men who will agree on the methods of identification to be used.

3. *Should this property be eventually restricted to seedlings, obtained from known parents only, or to all seedlings grown from seed or to canes recently gathered from a natural source, or should no restriction whatsoever be made depending upon one of these classes?*

   Restricted to canes of known parents only, for the sake of simplicity.

4. *If this is to be restricted to canes of known parentage, should the property be restricted to canes not yet in commercial cultivation, or should a*

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[1] General contribution from College of Agriculture No. 307.

minimum time be fixed that the cane has been in cultivation, or should it be made possible for all canes?

If restricted, a minimum time that the cane has been in cultivation or a minimum hectarage that the cane should occupy should be fixed.

5. *Do you believe it necessary to draw up special terms for canes already existing prior to a new regulation?*

Any law fixing property rights should not be made retroactive.

6. *Should it be preferred that no royalty is paid during the first years to enable testing of the cane without special costs?*

Yes.

7. *Should the possibility be secured to preserve the right of cultivation of a new cane variety exclusively for a special country or for a local group of interests?*

No geographical limit should be set. Any country should be allowed to grow a patented variety provided the country pays for a right to cultivate it.

8. *Do you believe it necessary to have regulations in every country apart before making an international one?*

Yes.

N. B. Mendiola
Of the Department of Agronomy

ABSTRACT[1]

A preliminary investigation on the living conditions of common laborers in the College of Agriculture, Los Baños, Laguna. CESARIO BANDONG. (*Thesis presented for graduation, 1929, from the College of Agriculture No. 409; Experiment station contribution No. 797.*)—The object of the author was to make a preliminary study of the living conditions of the common laborers in the College of Agriculture, and to find out which class of laborers had the better conditions of living. Also, to determine whether the wages of these laborers in the College of Agriculture are sufficient to meet their daily expenses.

Forty-five families living in the barrios near the College of Agriculture were studied. These families were divided into three types, fifteen families in each type: (1) those who were dependent upon their daily wages only, (2) those who were dependent upon their daily wages and farm income, (3) those who were dependent upon their farm income only. Each family was given sets of questionnaires that they filled in for seven months. These were collected by the investigator at the end of every month.

The questionnaire included records of itemized income and expenses, inventory of farm produce and other property outside of the farm. The number of individuals supported and dependents was also recorded.

The author found that the type II laborers of the three types studied had the best living conditions. The number of persons to a family in the three types of laborers ranged from 2 to 10. All families studied spent more for their food than for any other commodity. As shown by the data type I laborers spent 63.36 per cent of their total expenses for food; type II, 53.72 per cent; type III, 65.12 per cent. Rice, meat, vegetables, fish and bread constituted the largest items for their expenses for food. The rest of their expenses, expressed in percentages of total income were:

Items	*Type I*	*Type II*	*Type III*
For clothing	10.14	09.06	11.49
For luxury	9.66	10.43	10.11
For fuel	2.33	2.48	2.79
For miscellaneous	2.76	2.93	1.67

The average expenses for a period of seven months of type I laborers was ₱523.65; type II, ₱626.51; type III, ₱564.71. The average income for the same period was ₱593.21 for type I; ₱797.18 for type II; ₱617.87 for type III. These figures show that none of the families studied spent their whole income.

—*Abstract by Agapito B. Muyargas.*

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[1] Abstract presented as part of theme work required in English 3a, College of Agriculture

A GRATIFYING LETTER

UNITED STATES OF AMERICA
COMMISSION OF THE PHILIPPINE ISLANDS THE
INTERNATIONAL COLONIAL AND OVERSEAS
EXPOSITION AT PARIS

January 21, 1932.

DR. BIENVENIDO M. GONZALEZ,
Dean, College of Agriculture,
Agricultural College,
Laguna.

MY DEAR DEAN GONZALEZ:

It gives me great pleasure to inform you that the three complete sets of volumes XIV to XVIII inclusive of the Philippine Agriculturist which you very kindly furnished us for exhibit in the Philippine Pavilion in the International Colonial and Overseas Exposition attracted no little attention in Paris and were in the main responsible for the award of Diploma *D' HONNEUR* given the University of the Philippines by the International Jury for Class 13, "Books, Musical Publications, Binding, Newspapers".

Very truly yours,

(Sgd.) LEOPOLDO A. FAUSTINO,
Technical Director of Exhibits.

EXCHANGE NOTES

For the purpose of seeing fruit packed under organized direction, the writer returned through the United States of America, via California, Oregon, and Washington. At Los Angeles two packing houses were visited. One was devoted to the packing of lemons; the other to the packing of oranges. The equipment of these packing houses was far more complete than any the writer has seen in Australia. Every operation, except grading for colour and general quality, and packing the fruit into the boxes, was carried out by machinery, which size-graded, washed and polished the fruit, and labelled, pressed, nailed, and strapped the boxes. Grading the fruit for colour and general quality was performed by girls who selected the fruit as it travelled before them on broad leather belts and packed it into different boxes according to its colour and general quality. The boxes when packed showed a "bulge" of at least 2 inches.

To one accustomed to seeing fruit packed in Australia, the boxes seemed abnormally full; but after watching them pass through the pressing, nailing, and strapping machines, one realized that this method of filling and pressing the boxes was one reason why American consignments showed such small proportion of "slack" boxes when offered for sale on the European markets. —*The Journal of the Department of Agriculture of Victoria*, Australia, October, 1931.

The age of the earth is at least two thousand million years. This is the verdict of a committee of scientific men appointed by the National Research Council who have investigated, for the past four years, this basic problem of science.

The radioactive minerals uranium and thorium, which spontaneously disintegrate into lead, give the best clue to the earth's age. By carefully analyzing the radioactive minerals and their products in a sample of rock, it is possible to tell how long it has been in existence.

The oldest rock in the world, whose age has been determined in this way, is a piece of uranite or unranium-bearing rock from Sinyaya Pala, Carelia, Russia. It is 1,852 million years old and as it occurs in rocks, which therefore must be older, it is concluded that the age of the earth must be in round numbers at least two thousand million years.

—*Science* (*Science News*) March 13, 1931.

The Smithsonian Institution and the New York Botanical Garden are coöperating in the preparation of bibliography covering the literature of the botany of China including Tibet, Corea, Manchuria, Mongolia and also Japan and Formosa. It is estimated that there will be about 8000 titles and it is hoped that the bibliography may be off the press by the end of 1933. This colossal task is being undertaken by Mr. E. H. Walker of the National Herbarium and Dr. E. D. Merrill, Director of The New York Botanical Garden. A brief abstract, sufficient to indicate the scope of the article or book, will be given for each title. The bibliography is to be published in the *Contributions From the National Herbarium.* Literature relating to the botany of China is widely scattered and difficult of access so botanical workers, especially those residing in China, will welcome this bibliography.

—*Lingnan Science Journal* (China) August, 1931.

According to "Izvestia," official organ of the Soviet Government, a commission has been formed recently consisting of engineers and economists of the "Soyussakhar" (Sugar Combine of Soviet Russia) to draw up revised working plans for the development of the sugar industry during the period 1933-37. During this period attention will be given to the production of sugar from sources other than beets, such as corn, chicory, soya beans, and other sugar-containing plants. Another phase of the development programme will be the mechanisation of field work by the introduction of tractors for sowing and harvesting operations. Apart from the introduction of modernised methods in the existing fields, new fields over a large area will be cultivated.

The technique of the sugar industry will undergo a radical reorganisation through the switching over of the period of sugar production from a seasonal campaign to continuous operation of the factories through the establishment of beet drying plants.

The commission also will make a study of the utilisation of sugar waste for feeding purposes as a means of developing the cattle-raising industry.

—*The Australian Sugar Journal*, Octobei 8, 1931.

A study of the different varieties of papaya showed that their fruits varied appreciably in their yield of papain. Soil conditions also affected the yield considerably. A plant grown on a shady, rich soil, yielded four times as much juice as a plant of the same variety grown on a poor soil exposed to sunshine. The difference in yield was due to a certain extent to the higher number of fruits occurring on the plant grown in good soil. An examination of the results, however, showed that the high yielding tree gave more papain per 100 gm. of fruit than the low yielding tree.

—*Tropical Agriculture*, July, 1931.

COLLEGE AND ALUMNI NOTES

On Saturday, January 23, Dr. L. B. Coffman, President of the University of Minnesota, addressed the faculty and student body of the College. The address was informal with the main theme, the maintenance and progress of civilization will depend upon science. Doctor Coffman is a forceful, convincing speaker. Evidently he has little patience with the policy of "muddling along".

Professors W. A. Riley and W. H. Cummings were recent Campus visitors. Dr. Riley is Professor of Entomology at the University of Minnesota and at present a visiting professor at Lingnan University, Canton, China. Mr. Cummings was on his way to take charge of agricultural development work in a Mission School at Pyinmana, Burma, and stopped over to get some ideas of the problems and organization of a tropical agricultural school.

The standing committee on the Baker Memorial Scholarship composed of the Dean, Secretary and Head of one department (in rotation, this year, agronomy) awarded the scholarship to Juan Padilla and Marcelino G. Canlas of the class of 1932. According to the rules approved by the Board of Regents this scholarship is awarded to a self-supporting student or students in the senior class "on the basis of character, promise of future usefulness, and scholarship."

Juan Padilla is from Alaminos, Pangasinan. He is graduating under the six-year curriculum. His average in his studies for six years and three summers attendance excluding second semester, 1932, is 2.6. His name has never been recorded in the periodic delinquency report for poor scholarship. Mr. Padilla is an active member of Self-made Man Association, The Grain Reapers, The Rancher's Club and the Los Baños Cadet Band. He is majoring in Animal Husbandry, specializing in poultry.

Marcelino G. Canlas is from San Fernando, Pampanga. He is graduating under the six-year curriculum. He entered college with two years advanced credits. His average in his studies for five years and three summers is 2.4. His name has never been recorded in the periodic delinquency report for poor scholarship. He is majoring in Agricultural Chemistry.

Because the scholarship records of these two applicants were so nearly equal and all other conditions very similar the committee decided to divide the scholarship aid. This aid is the interest on the Baker Memorial Scholarship Fund.

Hearty congratulations are due these two young men. They are the type that Dean Baker esteemed highly—and the type that the fund in his memory was created to help and reward.

Dr. Valeriano C. Calma, B.Agr.'26 and B. S.Agr. '28 a recent arrival from the United States, is now connected with Department of Agronomy, as instructor in the Division of Farm Crops.

While Mr. Calma was studying in sugar technology in the Audubon Sugar School, Louisiana State University, he was appointed Philippine government partial pensionado as a result of a competitive examination given in the United States which he entered and got second place. He obtained his M. S. degree in sugar technology in 1929.

In Iowa State College he majored in horticulture, with plant physiology and plant pathology as minors. He received his Ph.D. degree from this College in 1931.

Upon his arrival in the Islands a few months ago, Doctor Calma was appointed to the position of horticulturist of the Philippine Bureau of Plant Industry. He resigned this position to accept the post offered to him in the College of Agriculture.

The sixty-eighth meeting of the Los Baños Biological Club was held on December 17, 1931, at 7:30 p. m. in the Lecture Hall of the Department of Agricultural Chemistry of the College of Agriculture.

The following papers were read and discussed:

1. "The probable rôle of blood-sucking helminths of animals affected with surra."—By Dr. L. M. Yutuc.
2. "Observations on the activity of Philippine carabao in the barn."—By Dr. Valente Villegas and Mr. A. T. Taleon. (Read by Mr. Taleon).

In honor of Dr. and Mrs. F. T. Adriano of the Chemistry Department who are leaving, Dr. and Mrs. R. B. Espino gave a delightful dance in their home on the evening of January 9, 1932.

The Agronomy 12 (Tobacco) class under Messrs. Vicente B. Aragon and Manuel R. Monsalud of the Farm Crops Division of the Department of Agronomy, went on an excursion to Manila on November 28, 1931. The following places were visited: Bureau of Internal Revenue, La Insular Cigar and Cigarette Factory, and the Philippine Aromatic Cigarette Factory. The students were able to gather first hand information relative to the different operations involved in the manufacture of cigars and cigarettes, the methods and regulations in the classification of leaf tobacco, some insect pests and diseases affecting leaf tobacco, etc.

Mr. Eliseo K. Ongsansoy, B.S.M.E., U.P., '25, instructor in the Department of Agricultural Engineering, College of Agriculture, sailed on the *S.S. President Hoover* on January 2, 1932, for the United States. Mr. Ongsansoy is appointed U.P. Fellow to the University of Nebraska, U. S. A. to pursue post-graduate studies. He will major in agricultural engineering with mechanical engineering for minor.

A new condenser of the Schutte and Koerting Barometric Multi-Jet type, is being installed in the U. P. Sugar Mill at the College. This condenser is one of the Schutte and Koerting Company's small K-Barometric Multi-Jet Condensers, Size No. 4. This is the first of its kind ever to be installed in the Philippine Islands. It was donated by the above mentioned company to the U. P. Sugar Mill. Professor R. H. King and Mr. Leandro Ebro Jr. are in charge of the installation. Among those working under them are ten junior sugar technology students, who are having sugar mill practice in this local Sugar Central.

The Agronomy 13 (Cereals and Field Legumes) Class under Messrs. Vicente B. Aragon and Albino P. Varona and the Soils 10 (Soil Physics and Management) Class under Dr. Dionisio I. Aquino joined forces in an excursion and field trip to Central Luzon during December 21-23. The following places, mills, warehouses, etc., all in the province of Nueva Ecija, except the Alabang Station, were visited: (1) Alabang Rice Station; (2) Peñaranda River Irrigation System; rice mills and bonded warehouses in Sta. Rosa; rice mills and bonded warehouses in Cabanatuan; rice fields and irrigation system in the Central Luzon Agricultural School in Muñoz; rice thresher, mill, and bodega of the Central Luzon Agricultural School; and the Talavera Irrigation Project in San Jose.

Under the sponsorship of the Committee on Social Affairs in the evening of December 23, 1932, a lively Christmas party was given by the faculty of the College of Agriculture to the students who remained on the Campus during the Christmas recess. About three hundred students representing Freshmen, Sophomores, Juniors, Seniors, Rural High, Forestry and Veterinary groups participated. Under the leadership of Mr. Hugh Bousman, Protestant Student Pastor, the out-door games and community singing went off with a bang. The basket supper prepared under the direction of Mrs. Leon G. Gonzalez was a popular feature. Prizes were given to the winners in different games.

A faculty Christmas party for students who cannot go home for holidays has been an annual affair for many years. The first one was a bonfire meeting and supper suggested by Dean Baker. This party now is a most important feature of Christmas on the Campus.

The Third Student's Conference was held on the Campus or more specifically on the Protestant Chapel grounds from December 26-30. Although the third Conference this was the first Inter-denominational Young People's Conference to be held on the Campus. As to the delegates we quote from the *L. B. C. Nocturnal Chronicle* a conference daily:

> With 97 delegates and 22 leaders the first annual inter-denominational young people's conference opened at the famous Los Baños College Campus, Laguna, promptly at 2:30 p. m., December 26. There are 66 boys and 53 girls.
>
> There are thirty provinces represented: Abra, Bataan, Batangas, Bohol, Bukidnon, Bulacan, Cagayan, Cavite, Corregidor, Cebu, Cotabato, Ilocos Norte, Ilocos Sur, Iloilo, Isabela, La Union, Laguna, Lanao, Manila, Nueva Ecija, Nueva Vizcaya, Occ. Negros, Or. Negros, Pampanga, Pangasinan, Rizal, Sulu, Zambales and Zamboanga. Nine denominations have representations: Methodist, United Evangelical Church, Emilif Presbyterian, Disciples of Christ, Baptist, Mohammedan, Aglipay and Roman Catholic. Rev. Hugh Bousman, pastor of Los Baños College Chapel, is the dean and chairman of the Conference. Mrs. Bousman is the registrar.

The total registration was 130. Approximately 100 students and 30 teachers. The registration at the first conference held on the Campus was 30.

World problems of peace, Filipino national problems, and personal difficulties with a detailed study of the meaning of the Christian life were the principal topics discussed. Among the principal evening speakers were Dr. George Wright, Mrs. Asuncion Perez, Mr. Gabino Tabuñar, Dr. D. S. Hibbard, Rev. Matias Cuadra, Dr. Rebecca Parish. The main conference gatherings were held in the Outdoor Theater. The group conferences under the trees. One evening the beautiful pageant "The Moral Equivalent of War" was presented by Mr. and Mrs. Bousman.

On the evening of December 12, Miss Elvie Fraser, and Miss Katherine Turner of Department of English, presented "Walk the Plank" a musical revue at the College Auditorium. It was a benefit for the Cadet Band.

Misses Turner and Fraser adapted the original to our College life, and added many songs and features. It was well presented and well costumed. The pirates of the "Aggie-O" were all that pirates should be. As to the culprits—they were not craven but spirited as college culprits should be. The singing and dancing were worthy of warm commendation. Mr. José Borromeo at the piano and Mr. Jesus Crisologo on the violin made a most acceptable "orchestra"; and Mr. Alberto Felix as drummer added emphasis and gave thrills at the proper places.

The cast of characters follows:

Culprits

Stub	Mr. Panfilo Mangahas
Haji	Mr. Akas Suleik
Red	Mr. Venancio Duarte
Diki-Diki	Mr. Gabriel Flores
Kid Puncher	Mr. Rafael Roces, Jr.
Hard-tack	Mr. Demetrio Miranda
Rube Ballee	Mr. Raul Arana
More Pirate (Visitor from the crew)	Mr. Rasumon Macalandong
Rosy Lips	Mr. Jesus Segovia
Chief	Mr. Santos Belo
Mate	Mr. Praxedio Golez

Crew

Mr. José Erquiza
Mr. Leo Yadao
Mr. Pedro Asunción
Mr. Rasumon Macalandong
Mr. Manuel del Campo
Mr. Onofre Casupang
Mr. Concordio Mandac
Mr. Pedro Yadao

Japanese Dance as curtain raiser

Miss Pilar Elayda
Miss Andrea Balbin
Miss Miguela Avanceña
Miss Catalina Buela

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